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Edited by L. B. Mackenzie

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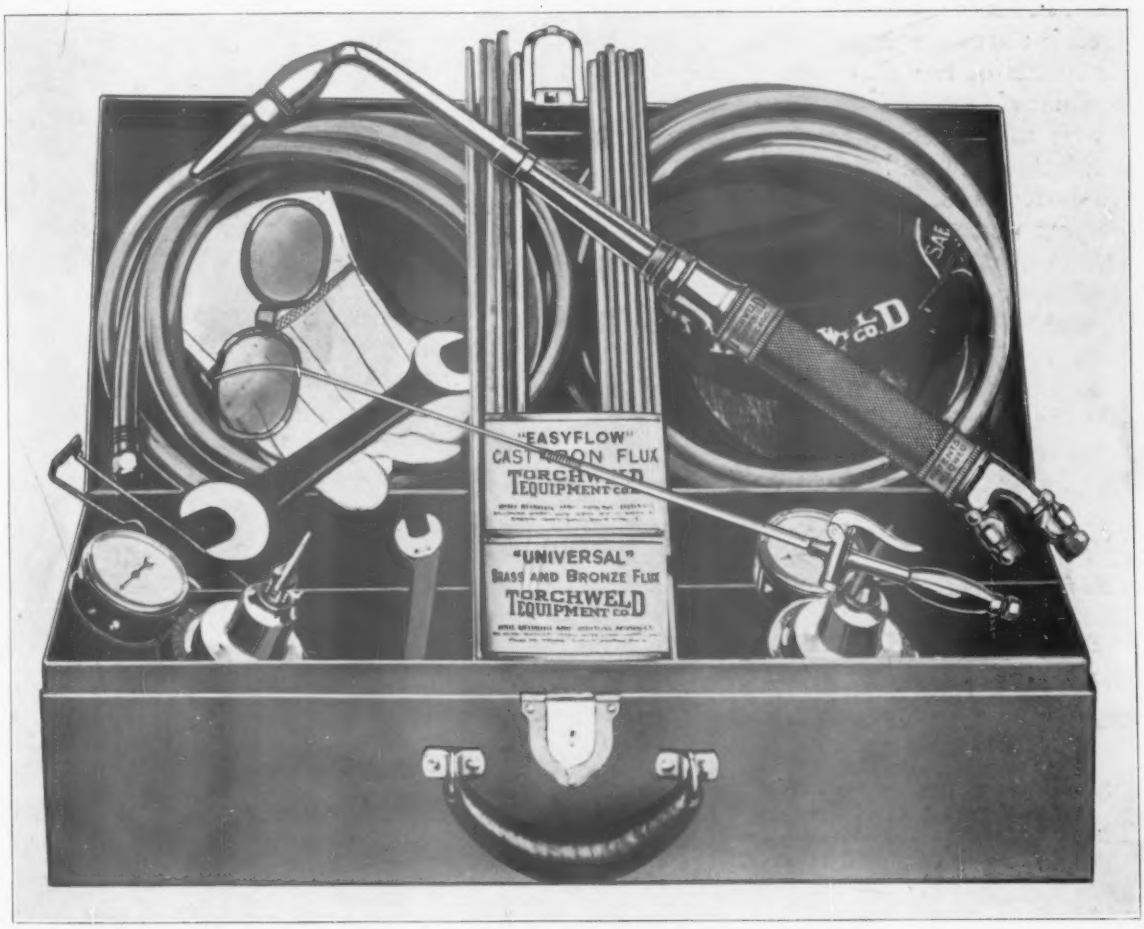

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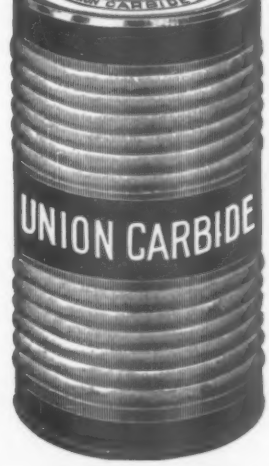

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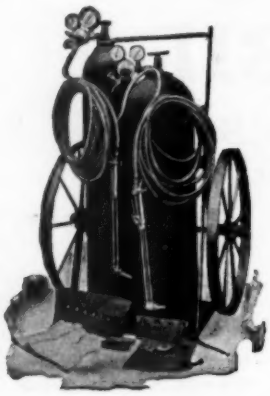


COMPLETE UNITS
INSTALLATIONS
GENERATORS
and SUPPLIES

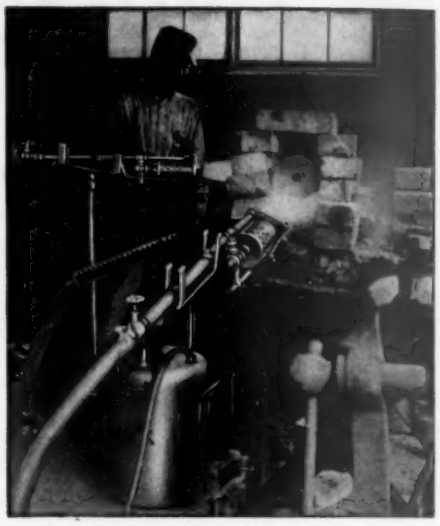
K-G WELDING AND CUTTING CO., Inc.

Home Office and Factory: 556 W. 34th St., New York City

Sales Offices:

PHILADELPHIA PITTSBURGH CHICAGO SPRINGFIELD, MASS. and NORFOLK

Reduce Overhead Expense



Welders do their preheating jobs at less cost than with charcoal or artificial gas.

There is absolutely no SMOKE or NOXIOUS GASES, and the DIRT that accumulates when charcoal is used is eliminated.

The burners are readily regulated to the desired flame by merely regulating the OIL VALVE.

HAUCK KEROSENE PREHEATERS are simple to OPERATE, and easy to HANDLE. They are equippel with hand pump; one pumping will operate the burner for three hours.

Write us for descriptive matter, or, still better, ask us to send you an outfit ON TRIAL.

HAUCK MANUFACTURING CO.

Makers of Oil Burning Equipment for Over Twenty Years

122 TENTH STREET : : : BROOKLYN, N. Y.

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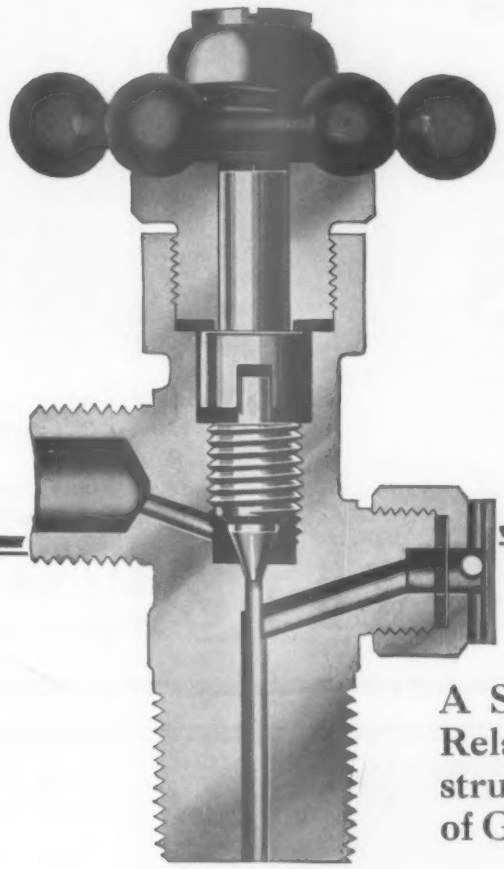
Burdett Standard High Pressure Valve



Here is a high grade single seat valve, at a popular price, designed to effect marked savings in gas distribution.

A Short Lesson in the Relation of Valve Construction to the Cost of Gas Plant Operation.

PART I

Valve seats that wear are wasteful of gas. The customer complains when tanks leak, and often refuses to order again. New seats have to be installed, the change costing money, time and material. Therefore, a durable, positively leak-proof seat is a prime essential to a good valve.

Weak spots in the construction of valves lead to broken valve stems, twisted valve tongs, spread plugs, tanks out of service, and expensive replacement.

PART II

The Burdett Standard Pressure Valve has a tapered seat tip, made of monel metal and held loosely, like a swivel, in the threaded plug. The tip does not twist or wear so there is no replacement expense nor gas leakage.

The plug is connected directly to the stem, giving sturdy construction which insures against broken stems and increases the life of the valve.

SUMMARY

For *Economy* specify Burdett Valves.

Safety discs and valves complete are thoroughly tested before shipping. All valves are fully guaranteed as to materials and workmanship.

BURDETT MANUFACTURING COMPANY

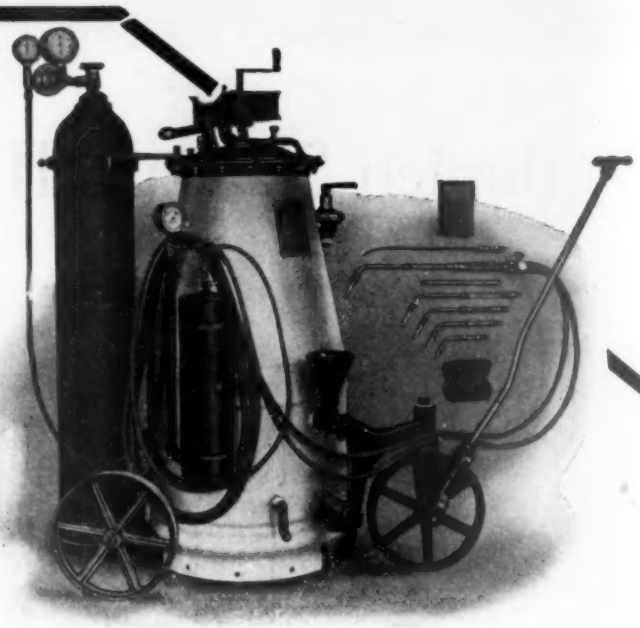
309 St. John's Court CHICAGO, ILLINOIS

A Small Investment That Pays

Big Returns

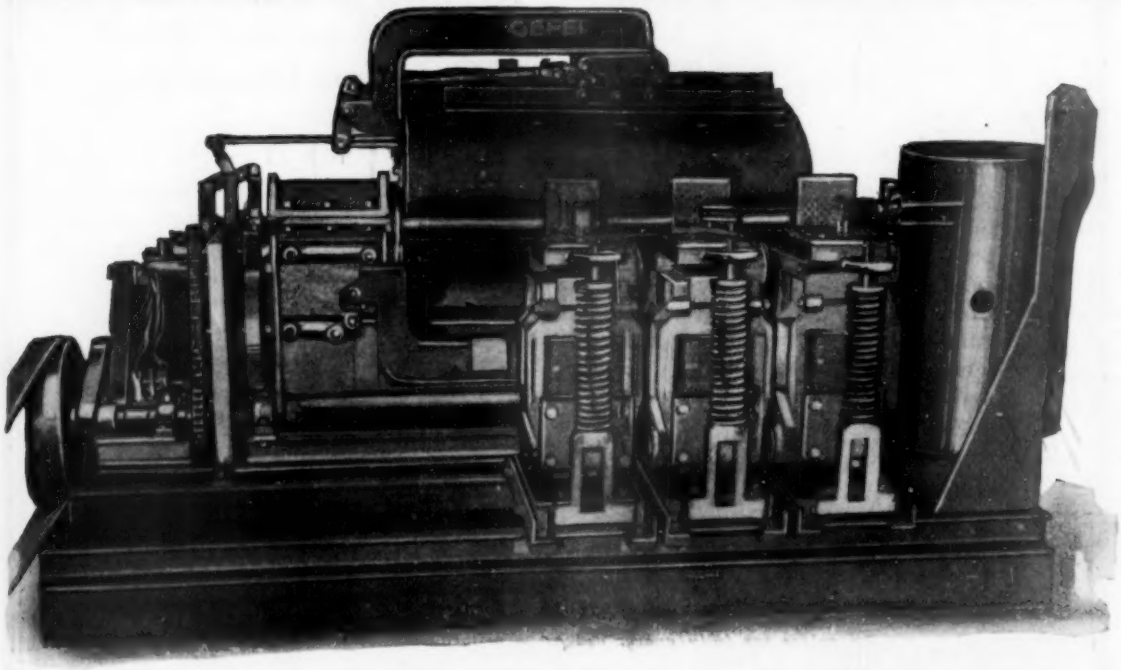
EVERYWHERE—in repair shops, in industrial plants—in service stations and—in all kinds of outside repair work, Smith's Welding, Cutting and Carbon Burning Equipment Plants are in strong demand—because they can be had in any size needed—because they are adaptable to all kinds of work—and because they enable the best welding and repair work at lowest cost.

The work they do is unlimited. They fix anything from an auto fender to a locomotive.



Smith's Welding, Cutting and Carbon Burning Equipment
No. 3
Made in Many Sizes
On Portable Trucks or Stationary

Smith's Inventions, Inc., 2617 4th Street S. E., Minneapolis, Minn.



Gefei-Tridor welds 450 feet of pressure tight seam of 95% strength in *one hour*

Is It Better To Use This or Compete Against Its Product?

37 different types of machines—a type for every purpose. Your type is among them.

GIBB INSTRUMENT COMPANY, General Motors Building, Detroit, Michigan

A Railway for Ideas

TWO business concerns with the same physical equipment and opportunities may enter the field at the same time. Yet, within a year, one may forge far ahead of its competitor. You have seen it happen many times. Why? Because one had **better ideas.**

Business failures are nearly all failures of ideas. The ability to acquire and use the right ideas is the measure of success or failure.

For every idea you originate, thousands are originated by others. For every idea you **believe** may work, thousands are tested in the laboratory of experience.

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An idea developed in New York is of no use to a Californian unless he hears about it. That is why there must be "railways" for ideas, channels for the exchange of constructive thought.

Business Papers are the "IDEA RAILWAYS" which bring you the best ideas in the world interpreted in terms of your particular kind of business. They are hardly less important than the railways of iron and steel. Without **"Idea Railways"** to effect a "meeting of minds" no sales could take place, no goods could be shipped.

A Shipment for You

Think of the money this service makes for you—saves for you. Conceive, if you can, of the increased expense and the crushing handicap which would be imposed upon both you and the concerns from which you buy, were your "Idea Railways" to be abolished.

The advertisers in these pages are progressive merchandisers, using the economical sales methods, made possible by this particular "Idea Railway." It pays to do business with people of this character.

YOU are invited to consult us freely about Business Papers, or Business Paper Advertising

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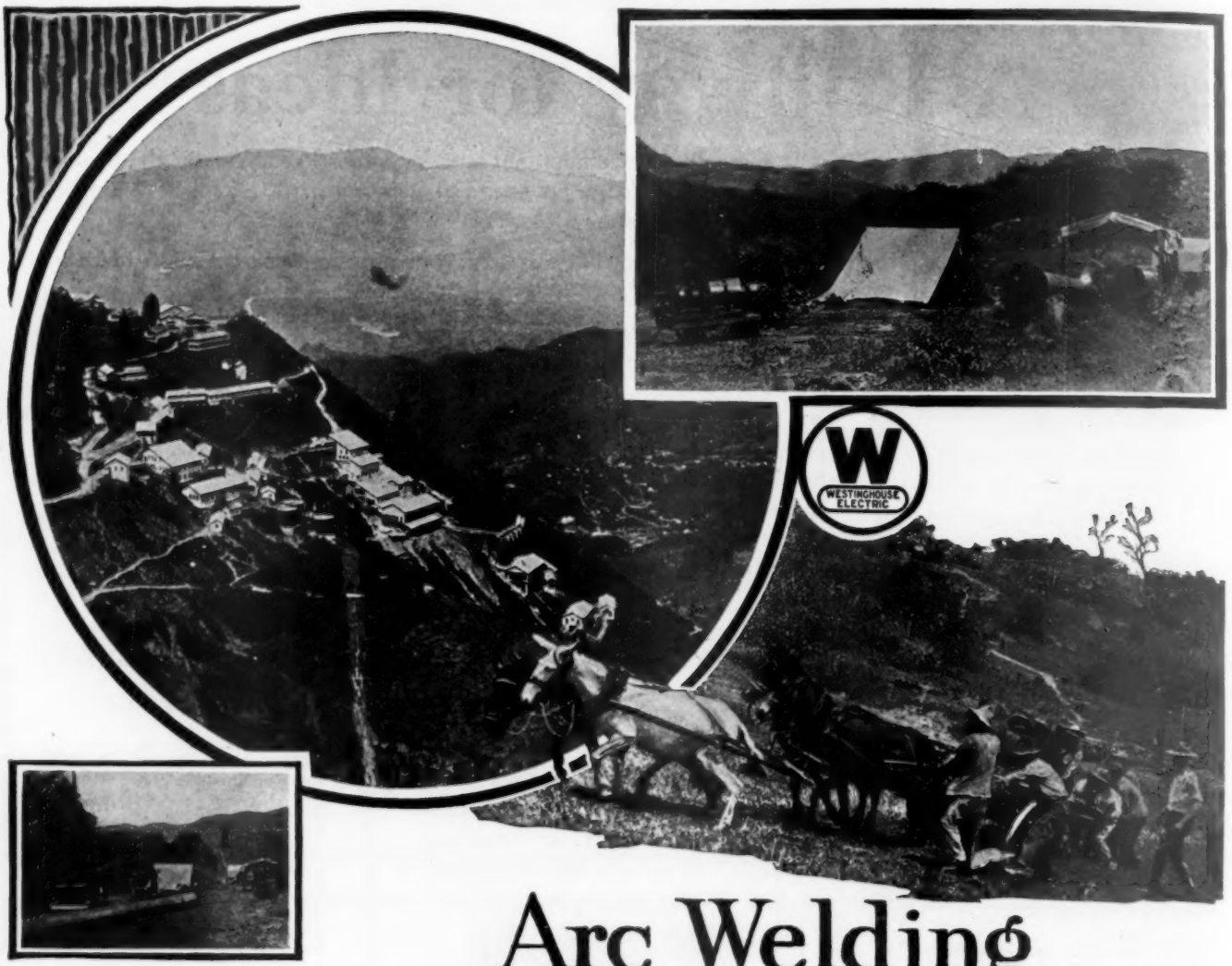
JESSE H. NEAL, Executive Secretary

Headquarters: 220 West Forty-second Street - - New York City



Arc Welding In Honduras, C.A.

3000 feet of 22 in. diameter pipe required repairs in San Jacinto, Honduras. Here is how it was done as told by the chief in charge.

"I need not go into details, it will be sufficient to say that the pipe was as thin as a piece of paper in some places while in others it was in perfect condition. The question arose as to which would be the cheaper, buy a new pipe, or repair the old one, so one of the worst lengths was taken out and repaired with the aid of our **Westinghouse welding outfit.** The result was we could repair the pipe and make it almost as good as new for one tenth the cost of a new pipe.

"The method employed to repair the pipe was the most simple possible. Three lengths were disconnected so that they could be turned around on the piers to make the welding operation as easy as possible for the operator. The defective places were then marked off, plates cut and bent to the required size and shape, put into place, and welded around the edges. This method may not appeal to some people, but 'the proof of the pudding is in the eating.' The pipe was then tested to double the working pressure and, barring a few beads of moisture appearing in places where the weld was slightly porous, the pipe was otherwise OK. These slight leaks only required a little tap with a hammer to eliminate them entirely."

Westinghouse Arc Welding Equipments are furnished in stationary or portable types for one or more operators and in all sizes from 175 to 1,000 amperes.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.
Offices in all principal American Cities

Westinghouse

Oxy—What are the most useful presents you know of?
Hy— Presence of mind.

99% PURE ELECTROLYTIC OXYGEN

is pure food for your welding and cutting torches. Avoid "near oxygen" by insisting upon 99% purity. Do your cutting with HYDROGEN.

Electrolytic Oxygen and Hydrogen Plants Everywhere

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Kentucky Oxygen & Hydrogen Co., Louisville

MANITOBA
Auto-Lite Gas Co., Ltd., Winnipeg

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Burdett Oxygen Co. of Detroit, Detroit
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Burdett Oxygen & Hydrogen Co., Pittsburgh, Pa.
National Oxygen, Erie

TENNESSEE
Burdett Oxygen Co., Chattanooga

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WASHINGTON
Washington Compressed Gas Co., Seattle

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Universal Oxygen Co., Sheboygan
Wisconsin Oxygen & Hydrogen Co., Kenosha

BRITISH COLUMBIA
Compressed Gas Co., Ltd., Vancouver

Gas Products Association

801 Marquette Building **Chicago, Ill.**

SUN-LITE CARBIDE

PACKED IN BROWN DRUMS

For Acetylene Compressing Plants, Oxy-Acetylene Welding Plants, House Lighting Generators, Contractors' Torches, Etc.

IN 100 lb. DRUMS

In All Commercial Sizes:

3½" x 2"
2" x ½"
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¼" x 1/12"

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Write for location of nearest sales agency, from which shipments will be made direct to consumer. Address all correspondence to the Home Office

GAS TANK RECHARGING COMPANY, MILWAUKEE, WISCONSIN

"RACO" Electrodes *and* Welding Wires

Blue Label

Colored labels in this style identify each different kind of RACO WIRE

The chemical analyses of the Seven different "Raco" Wires are published in an interesting booklet, the only one of its kind, which will be sent on request to any user of welding wires—no charge.

"Raco" Wires are sold under strict specification and are subject to rejection for any cause.

Rail facilities directly into the plant and a 500,000 pound stock, in 3-32 in., ⅛ in., 5-32 in., 3-16 in. and ¼ in. diameter make it generally possible to ship orders of any size, the day they are received.

Samples for testing and new current prices furnished promptly.

Reid-Avery Company

21st St. and Washington Ave.
PHILADELPHIA, PA.

WELDING RODS

Parsons' Manganese Bronze Rolled Welding Rods

the Strongest Bronze Made

for high-fire Brazing and Oxy-Acetylene Welding of Malleable Iron or Bronze and Brass castings assure a faultless, flawless job. This is another example of the "Cramp" standard of quality. This scientifically perfected metal is the result of long years of experience. Its fine physical properties make it especially suitable for welding purposes.

A strong weld of fine close grain and exceedingly tough texture is always the result where Cramp's Welding Rods are usesd.

We can also furnish Welding Rods of Cramp's Cast Iron, Cramp's Copper Covered Iron, Cramp's Vanadium Steel, Cramp's Drawn Aluminum, Cramp's Cast Aluminum, Cramp's American Iron and Soft Brass Brazing Wire.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

The William Cramp & Sons Ship & Engine Building Co., Philadelphia

Those who have enjoyed long association with CANADIAN CARBIDE have always assumed high standards of performance We are confident that if not already among the users of CANADIAN CARBIDE the day will come when you too will know the meaning of "More Gas per Pound"

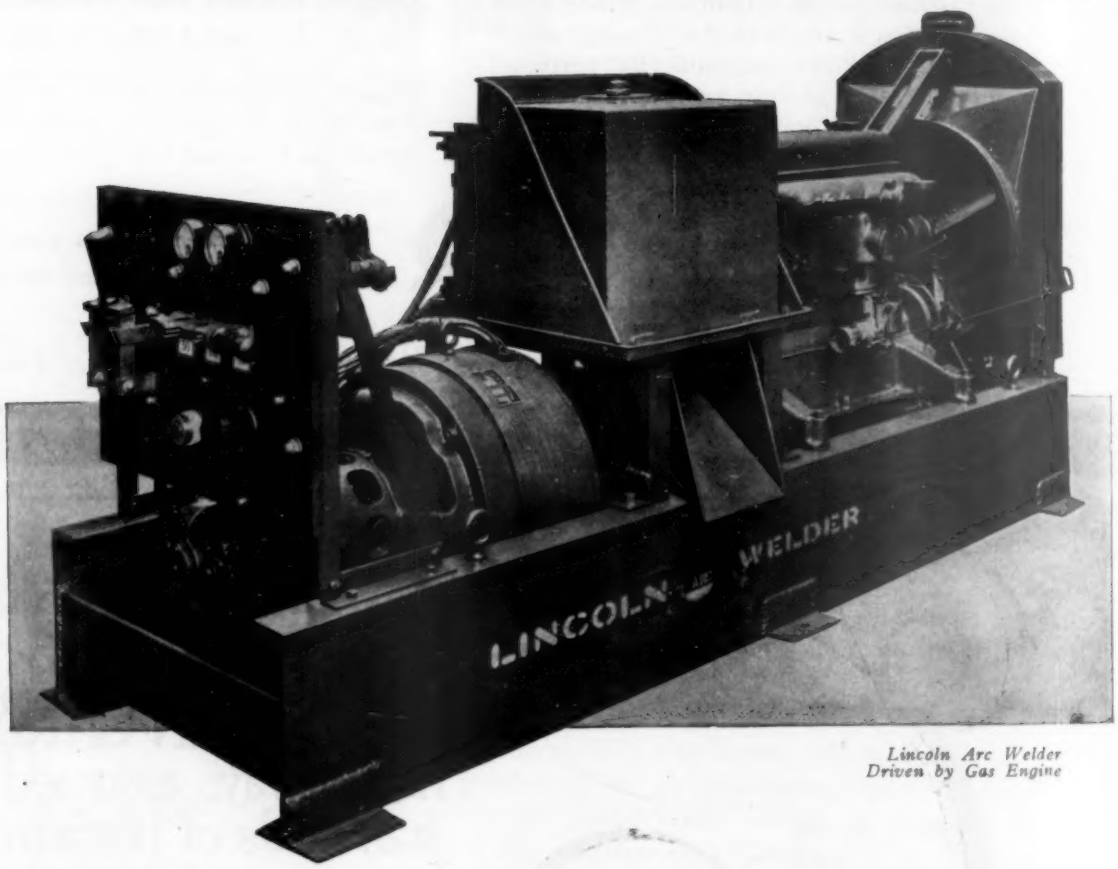
SHAWINIGAN PRODUCTS CORPORATION

110 WILLIAM STREET NEW YORK
549 McCORMICK BLDG. CHICAGO

SHAWINIGAN

LINCOLN ARC WELDER

The Commercial Welder Uses LINCOLN



Lincoln Arc Welder
Driven by Gas Engine

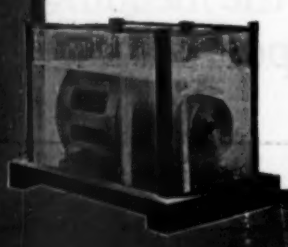
More job welding shops use the Lincoln Welder than all other makes of electric welder combined.

They know, because it is their business to know, that the Lincoln is the most economical to operate and will do more work per day.

They can operate the Lincoln Arc Welder satisfactorily with a gasoline engine which makes it portable for use on motor trucks, repair tugs, etc.

The Lincoln Arc Welder will weld heavy cast iron parts wherever they may be without moving them for pre-heating.

It is so flexible that it perfectly meets the job welder's requirements for electric welding equipment.



This Standard Lincoln Motor operated over 3 years under water without damage.

The Lincoln Electric Co.

General Offices and Factory, Cleveland, O.

Branch Offices in Principal Cities

The Lincoln Electric Co., of Canada, Ltd., Toronto-Montreal

Davis-Bournonville

Garage and Small Machine Shop Carrying Case Welding Outfit

A new torch and equipment, packed in a neat fibre case complete is offered at the low price of $55. The outfit consists of the following:

1 Torch, Style No. 7000

3 Extension Tubes
Style No. 7017, 5 in. long
Style No. 7018, 10 in. long
Style No. 7019, 15 in. long

5 Welding Tips
Style 9, sizes assorted from No. 1 to No. 7

1 Decarbonizing Tube
Style No. 7020

1 Oxygen Regulator
Style No. 5500

1 Acetylene Regulator
Style No. 5501

12 ft. Oxygen Hose, with Connections

12 ft. Acetylene Hose, with Connections

1 Sparklighter

1 Pair Colored Glasses

1 Torch Wrench

1 Regulator Wrench

Price complete, packed in fibre case, as shown, $55. An assortment of welding rods and fluxes, necessary for average welding jobs packed in a wooden box, is furnished at $6 extra.

Price of Outfit in Canada $65.

Davis-Bournonville Company

Factory and General Offices:
JERSEY CITY, N. J.

BRANCHES IN PRINCIPAL CITIES

Swift's Pure Oxygen

"A Reputation Imposes an Obligation"

Swift Oxygen must pass the most rigid tests—must never vary from its high quality standard.

Swift Oxygen is produced in the largest electrolytic plant in the U. S. A.—in ample quantities to render unequalled service to our customers.

The use of Swift Oxygen in your plant will aid you in raising the standard of the work of your operators.

The Name is Your Guarantee

Swift & Company,

Oxygen Department

Union Stock Yards Chicago, Ill.

Commercial Acetylene Is the Welder's Standard Specification

"COMMERCIAL" is the Mark of Uniform Purity

The name "Commercial" has been associated with dissolved acetylene since the beginning of oxy-acetylene welding. Commercial Acetylene is favorably known for its reliability, its uniform purity and its organization for service to the industry. The gas is absolutely pure and uniform, enabling the welder to maintain with ease the proper neutral welding flame.

If you buy acetylene you should become familiar with the COMMERCIAL plan. Buying the Commercial way means that you buy gas only—we loan you the cylinders. You USE what's inside the cylinders and that's all you pay for.

Acetylene supplied in portable cylinders of the following sizes and capacities:

10 in.	x 30 in.	size	-	125 cu. ft.	capacity
12 "	x 36 "	"	-	225 " ft.	"
12 "	x 44 "	"	-	275 " ft.	"

Submit your acetylene requirements to our nearest office.

Commercial Acetylene Supply Co.

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East Deerfield, Mass. — Boston, Mass. — Toronto, Ont.
San Francisco, Calif. — Bound Brook, N. J. — W. Berkeley, Calif.

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WELDING MANGANESE STEEL*

Frogs and Crossing Layouts Put in Service at a Fraction of the Cost of a New Installation

By H. R. Pennington†

AS actually made, manganese steel contains about 12 per cent of manganese and 1.25 per cent of carbon. The presence of 1.50 per cent of manganese makes steel relatively brittle and a further addition at first increases this brittleness, so that steel containing between 4 and 5.5 per cent can be pulverized under the hammer. A still further increase, however, gives it great ductility, accompanied by great "tough hardness"—a combination of properties which was not possessed by any other known substance when this remarkable alloy, known as Hadfield's manganese steel, was discovered. Its "tough hardness," to which it owes its value, is profoundly affected by the rate of cooling. Sudden cooling makes the metal extremely hard and ductile; slow cooling makes it brittle. Its behavior in this respect is thus opposite to that of carbon steel. High manganese steel is used extensively for objects which require both hardness and ductility, its remarkable toughness, resistance to shock and abrasive action make it ideal

Welded Manganese Frog Before Grinding.

for rock-crushing machinery, railway crossings, mine car wheels, tractor parts, etc. As no process softens manganese steel it must be cut to shape with emery wheels instead of the usual steel cutting tools. It may also be cut with the oxy-acetylene torch.

The extreme brittleness noticeable with steel containing manganese between 4 per cent and 5.5 per cent disappears in steel exceeding about 7.5 per cent manganese, as will later be shown by the physical qualities with respect to the manganese and carbon content.

A non-magnetic characteristic is noticeable around 8 per cent manganese, and at 12 per cent manganese it is practically non-magnetic. As it is extremely difficult to cold work anganese steel, manganese wire is drawn only by very special methods.

Manganese steel is a very poor conductor of heat; it having a relative conductivity of only 2.31 (Copper 100 per cent), or 75 michrons per cu. centimeter at 15° C. This is about one-seventh the conductivity of iron wire.

The following table shows the effect of varying quantities of manganese and carbon on the physical quality of the product, and will serve as a guide as to its limitations in this respect. The tests were made on forged manganese treated as indicated below:

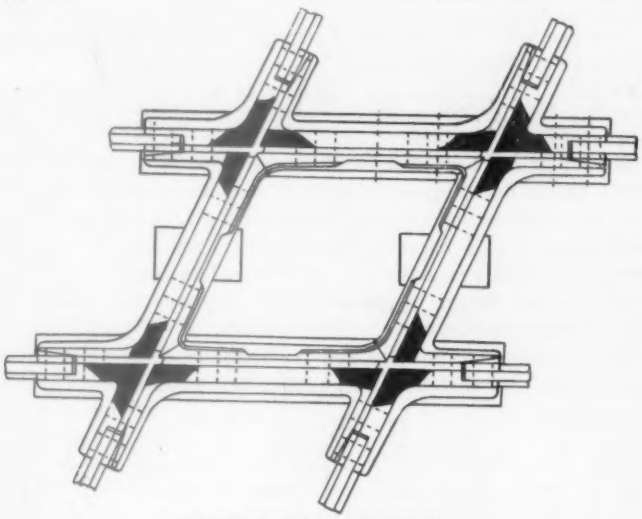

Diagram of Special Layout.

TABLE OF TESTS*

Test No.	Carbon	Mang.	Treatment	Tensil or breaking tons per sq. in.	Elongation percent 8 ins.	Appearance of Fracture
1	.52	6.95	Cooled in air. from white heat.	21.07	1.50	Coarse and granular.
2	.52	6.95	Cooled in oil from white heat.	18.76	2.34	Very coarse and bright.
3	.52	6.95	Cooled in water from white heat.	23.25	1.56	Coarse and granular.
4	.50	7.90	Heated as above cooled in air.	28.35	7.81	Coarse and granular.
5	.50	7.90	Cooled in oil.	29.61	7.03	Coarse and granular.
6	.61	9.37	Cooled in oil.	38.20	14.84	Coarse and granular.
7	.61	9.37	Cooled in water.	38.87	14.84	Finer.
8	.95	10.11	Cooled in air.	39.29	14.06	Coarse and granular.
9	.95	10.11	Cooled in oil.	41.00	19.53	Coarse and granular.
10	.72	10.83	Cooled in water.	47.53 to 53.14	22.0 to 28.9	Coarse and granular.
11	.85	12.29	Cooled in water.	55.12 to 64.84	35.9 to 45.31	Coarse and granular.
12	.85	12.29	Cooled in air.	39.34	3.5	Fibrous.
13	1.10	12.60	Cooled in water.	53.91	27.34	Fibrous.
14	.85	13.75	Cooled in water.	60.60	47.6	Fibrous.
15	.85	14.01	Cooled in water.	67.13	44.44	Fibrous.
16	1.55	14.16	Cooled in water.	44.84	14.06	Carbon too high.
17	1.1	14.48	Cooled in water.	63.36	37.5	
18	1.54	18.4	Cooled in water.	53.24	10.1	Carbon too high.

The above test although made several years ago in England by Sir Robert Hadfield, shows a number of interesting results, especially from a welding point of view. For example, the beneficial effect of sudden cooling in cold water is clearly shown as indicated by tests Nos. 9, 10, 11 and 13.

Test Nos. 4, 5 and 6 show approximately the minimum amount of manganese and carbon above the amounts present in the usual

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Institute of Civil Engineers, Minutes of Proceedings, 1887-1888, Vol. XCIII.

manganese steel from which any beneficial effect is noticeable. The quality increases with increase of carbon and manganese up to about 1.00 per cent carbon and 12 to 13 per cent manganese, as shown by test Nos. 11, 13, 14 and 15. Test No. 16 shows the bad effect of an excess of carbon content.

The beneficial effect of sudden cooling, as well as the good physical qualities which may be obtained within a fairly wide range of carbon and manganese between the maximum and minimum limits is reassuring, especially as regards sudden cooling, as this feature is greatly facilitated by arc welding, which permits cooling as frequently as necessary with but little interference with the welding operation. By use of a proper protective coating on the electrode, sufficient carbon and manganese will be retained in the weld or "arc deposited metal" to insure being within the desired limits as will later be shown.

Chemically the usual cast manganese steel has about the following composition:

	Pecent
Carbon	1.25
Silicon	0.30
Manganese	12.30
Sulphur, less than	0.02
Phosphorus	0.08

The average of a number of physical tests of cast manganese steel of the above analysis, show the following results:

Tensil Lbs. per sq. in.	Elastic Limit— lbs. per sq. in.	Elongation percent. in 2 in.	Reduction of area percent
108,460	53,396	33.71	38.56

By the Brinell test, manganese steel toughened or untoughened, shows the moderate average hardness number of about 200. The extreme outer surface of the treated steel shows a slightly lower number—that at a depth of about ⅛-in., from which point the number remains constant. The lowering of the hardness number at the surface is due to the oxidation of the carbon during the heat treatment.

The chemical composition and physical properties of the manganese rods and wire used for welding are as follows:

Chemical	
Manganese	11 to 14%
Carbon	1.00 to 1.30%
Silicon	0.10 to 0.20%
Phosphorus	0.05 to 0.09%
Sulphur	0.01 to 0.03%
Test: Rolled and Forged.	
Ultimate tensil strength	140,000 to 160,000 lbs.
Elastic limit	60,000 to 75,000 lbs.
Elongation	35% to 50%
Shearing strength	100,000 to 110,000 lbs.
Cold Drawn Wire.	
Test on ⅛-in. Drawn Manganese Steel Wire.	
Wire not heat treated after last draw.	
Ultimate tensile strength per sq. inch	193,000 lbs.
Elastic limit per sq. inch	135,000 lbs. (70%)
Elongation	20% in 8-in.
Turns	4
Torsions	15 to 8-in.

The beneficial effect of the cold working incidental to drawing to wire form is very marked, particularly the tensile strength and elastic limit. In the same way it is believed that the metal added by welding to a crossing or frog is improved in the early period of service, due to the constant rolling effect of the passing traffic.

The following test shows the average percentage loss of carbon and manganese for a Wanamaker Coated Electrode No. 9 when fused by the metallic arc process and deposited on a carbon steel rail.

Analysis of wire before welding:

Carbon	0.99%
Sulphur	0.022%
Phosphorus	0.043%
Manganese	10.51%

Analysis of deposit on rail made from above wire:

Carbon	0.71%
Sulphur	0.018%
Phosphorus	0.061%
Manganese	10.19%

The following tests were made to show the effect of polarity and the influence of the base metal on the composition of the deposit, the deposit being made on a piece of mild steel ⅝-in. boiler plate.

	Wire Electrode	Electrode Neg. Deposit	Electrode Pos. Deposit
Carbon	.85	.63	.83
Manganese	11.2	8.11	8.11
Phosphorus	.....	0.034	0.032
Sulphur	.....	0.010	0.012
Silicon	.....	.....	.....

A greater loss of manganese is shown by the deposit on the mild steel plate over that obtained on a carbon steel rail. Concerning the effect of polarity, a greater loss of carbon is shown when using electrode negative than that obtained with the electrode positive. The usual practice is to use an electrode-positive polarity for manganese electrode material.

In the cast state, manganese steel is composed principally of austenite and free cementite, austenite being a solution of iron, manganese, and the carbide of iron and manganese, while free cementite is composed of the carbides of iron and manganese which remain undissolved. Free cementite is hard and brittle, therefore manganese steel is also brittle in the untreated cast condition. When, however, it is water toughened, the free cementite is dissolved and the cast manganese becomes austenite, which is ductile. In the process of toughening it is quenched from 1800°F. in cold water.

The proper temperature from which arc deposited manganese steel should be quenched is a point which has been questioned by some investigators. Some tests have shown a falling off in tensile properties and elongation on quenching from a temperature in excess of 1800°F. The following tests made on ⅜-in. diameter round bars heated to the temperature given for one hour, and quenched in water, tends to confirm this belief. The duration of heating, however, has almost as important an effect as the temperature itself.

**Heated 1 hr. at	Elongation percent	Breaking strain lbs. per sq. in.
1800° F.	56.5	133,400
2100° F.	35.7	93,200

Another test made on the same material by heating test pieces to the temperature shown for only five minutes, shows a considerable less lowering of the tensile and elongation properties, as indicated below.

Heated five minutes at	Elongation percent	Breaking strain lbs. per sq. in.
1800° F.	56.4	142,450
2066° F.	34.4	124,780

In this case the higher temperature did not effect the elongation and tensile strength nearly as much as when heated at the higher temperature for a period at one hour. The short time at the maximum temperature apparently did not give the steel quite enough time to come fully to equilibrium. In consequence, the structure of the test bars was not greatly altered from that much existed prior to the heat treatment. All test bars when quenched from the heat of rolling showed the following properties, without further heat treatment.

Elongation percent.	Breaking strain lbs. per sq. in.
53.3	157,250

In the process of welding, the time period for the heating and cooling cycle is a matter of seconds due to intermittent cooling of parent metal with cold water. For this reason the physical properties of the arc fused metal although cooled from the melting point 2462° F. to 2507° F. would not be injured in any way comparable to that where the metal has been heated for a comparatively long period.

The same lowering of tensile strength and elongation is shown when manganese steel is drawn or quenched from some lower temperature points than the established practice 1800° F. and when the usual method of heating is employed. In the case of

****American Institute of Mining Engineers, Vol. L., 1914.**

arc welding however the metal adjacent to the arc deposited metal cooled from these lower temperatures is not thought to be injured for the same reason as in the case of cooling from extremely high temperatures, i. e., the rapid heating and cooling incidental to arc welding, would not give ample time for normal structural changes to occur.

METALLIC ARC WELDING OF MANGANESE STEEL

So far as known, the commercial welding of manganese steel up to the present time, was accomplished only by the metallic arc process with coated manganese electrode material and by water toughening the added metal, the metallic arc form of autogenous welding being particularly adapted to the welding of metal of this character, since it is about the only form of autogeous welding which permits, without difficulty, the water toughening treatment of the added metal.

The normal water toughening treatment amounts to raising the temperature of the metal until the desired structure is produced, and fixing it at that point by an increase of the normal cooling rate. Likewise, in the case of welding manganese, the metal heated to a high temperature by the welding operation, is suddenly cooled from a temperature as near equal to that for the desired structure as is possible.

Electrode Material

The use of a protective coating of the proper character on the electrode material, is necessary to prevent vaporization of the manganese and carbon constituents due to combustion, supported by the oxygen of the atmosphere. The function of the coating is to envelope the metal in fusion with a thin slag film, confine the arc gases and exclude to a great extent, the atmospheric gases.

The coated manganese steel electrode material is furnished in the following standard sizes:

Diameter	Length
1/8-inch drawn	14 inches
5/32-inch drawn	14 inches
1/8-inch rolled	14 inches
1/4-inch rolled	14 inches

The size most generally used for track work is 1/8-inch and 1/4-inch. The 1/8-inch size seems better adapted for general work, especially where 200 ampere welding units are used.

The approximate are current and voltage values for manganese electrode material are as follows:

Diameter Electrode	Approx. Current Arc	Approx. Voltage Arc
1/8-inch	100-120	20-25
5/32-inch	150-170	22-28
1/8-inch	175-200	25-30
1/4-inch	225-275	25-30

The arc length should be maintained as short as consistent for a uniform flow of metal about 1/8 inch. If with this arc length the metal does not flow smoothly, it is likely that the arc current value is too low.

Polarity

In practice it is found that an electrode-positive polarity gives a better welding characteristic and that the loss of carbon and manganese is less. For this reason where direct current is used, the electrode is made the positive and the work piece the negative.

Arc Manipulation

When welding with manganese steel on either manganese or high carbon steel, it is found advisable to form a rather wide deposit by a slight oscilation of the electrode, to give a deposit approximately double the width of that obtained by drawing the electrode along a straight line. By this manipulation the deposited metal is kept in a molten condition for a slightly longer period, allowing time for the escape of any gas which may be included in the deposit, and thus preventing the formation of blow holes.

Water Toughening

To prevent the formation of a brittle structure, the work piece including the weld area is kept cool by quenching with cold water *immediately* after each electrode is used and more often on light sections where the part tends to become too hot, or at any time the welding is interrupted. The result to be accomplished is to keep the work piece cool enough to exercise constantly a quenching action on the deposited metal. Unless the cooling by water is frequent, the rate of cooling will be variable with a corresponding difference in physical character of the added metal.

In track work the cooling is accomplished by directing a small stream of water directly on the previously deposited metal until the heat retained in the part will just dry or vaporize the water. Before the welding is again continued, the surface where the arc is to be established must be dry, otherwise difficulty will be experienced in establishing the arc. It is desirable to wipe the surface dry with a piece of waste when necessary before starting the arc.

Welding Procedure

When building up track parts, such as frogs and crossings, it is advisable to apply each deposit diagonally to the direction of the traffic, and terminate the weld on a bias, the point of the bias being on the flange side of rail, as shown by the accompanying sketch. This procedure is thought to be the best practice in order to minimize the effect of contraction and possible structural disturbance on the parent metal from the heat of the welding operation.

To avoid roughness or overrunning of the added metal at the flange side of the rail and on both sides of points, a piece of fire brick or carbon block should be set in the flange groove so as to project up and form a wall for the added metal to flow against. The use of fire brick or carbon blocks for making forms at the extreme points and edges will greatly facilitate the welding and result in better and more uniform work.

Where welding is done out in the open, a small shield 8 or 10 inches high should be set up to shield the arc from the eyes of observers and from air drafts, especially on windy days. Unless the arc is protected from air drafts, welding will be very difficult and an unnecessary loss of carbon and manganese will result.

Finishing

If desired, the weld may be finished by grinding to allow a smooth approach for the wheel and prevent impact at the junction of the weld. However, if pains are taken by the operator to make as smooth a weld as possible, grinding is not considered absolutely necessary. The natural flowing characteristic of manganese steel will in a short time result in the weld becoming quite smooth. The operator should not only endeavor to make a smooth weld but should also use care to see that the top of the weld is level with other parts of the track work, being particular to avoid sharp humps or low spots.

The records of a number of applications which have been made in both steam railroad and street railway tracks, seems to leave little doubt as to the commercial success of arc welding manganese steel. On a service cost basis, the service already obtained from welded crossings is such as to insure the permanency of the process.

DISCUSSION

MR. WOLFE: A point which I think is worth making in regard to this work is, that in order to make sure of getting the longest life for the top of a rail, you must do a good job of grinding. Manganese steel is rather soft at first and will roll down hard—then it will last for years, but the grinding must be done properly to secure the kind of surface that will last the longest.

In 1907, the city ordinances called for electric welded rail joints or rail joints which would have 100 per cent conductivity. At the time, the Lorain welding process was adopted for making rail joints. This type of joint was used until ten years ago. However, in the installation of a good many of these joints, the grinding was not done perfectly. The result was hundreds of joints have been removed since, on account of faulty grinding, which led to cupping of the rails at the joints.

In 1912, we started using the Indianapolis welding machine with a high carbon steel wire for building up worn spots on special work. We found that the temper of the metal was destroyed to some extent, and that there were apt to be big holes left just inside of the welded area. At present we keep three equipments working every night building up on special work which is worn out to such extent that it will soon be ready for renewal. We know that it will break out soon anyway, but we figure on it lasting from one day to six months, but we keep the special work in service until it is worn out all over. That is, the patching up of two bad frogs preserves the layout until the whole thing is ready for replacement.

A short time ago the Lincoln welder was adopted for the making of rail joints. With the Lincoln process we use a low carbon steel rod for a filler and use a carbon arc with an electrode negative, so as not to draw carbon into the weld.

The metallic arc process with a high carbon steel wire is now being used to weld the tops of rails, if they are cupped at the joints. This has been proven very successful on high carbon rails. After a year's service, it is almost impossible to detect the fact that the weld has been made and there have been practically no failures.

Last July the first trial with Wanamaker elctrodes was made on a layout at Monroe and Clark Streets. The Indianapolis welder was used with 550 volt current. The process of quenching, as described in Mr. Pennington's paper, is as follows: We used water by the bucket full at first, but it soon became mighty unpleasant for the welder, so now we use as little water as possible, dipping it out of the pail with a tin cup. Fifty or sixty special layouts have been welded in this way so far, using some four hundred pounds of manganese steel wire, and they all look like new. The first one welded required ten pounds of wire. This was in the heart of the loop district where the traffic is heaviest.

In our work we have found that it is absolutely necessary to have the work welded on its foundation if we are to get a good job. No joint should be welded unless it is solid, because there is always a certain amount of weaving. This refers to joint welding.

With reference to the importance of grinding. In welding on track work, it will be well to make a grinder a part of the welding equipment. Every welding crew has a grinder as part of the welding equipment. That grinder stays with the welding machine.

On special work we use an Atlas grinder for heavy grinding and a hand grinder for grinding out the grooves. One difficulty of welding on street railway tracks is that the work must be done under traffic. All of our work on building up frogs and crossings is done at night. The traffic is not so heavy, but the work has a large element of danger, because there is so much fast automobile traffic. The welder who works on a street railway does not have a very large variety of jobs, but the conditions under which he works are very troublesome.

MR. JONES: We have done considerable welding of this nature, but I believe that we have found it good practice to use water in considerable quantities. In fact, we squirt it on with a hose and quench two inches of the welded metal at a time. The only failure which we have had was in the welding of a broken rail.

MR. WOLFE: The difference in the method of quenching is due to the difference in the method of placing the track. Our work is all on track which is laid in the pavement. The track which Mr. Jones speaks of is out in the open and there is plenty of chance for the water to run away. There is no drainage in the pavement where we work, so if very much water is used it all lies on top of the job and the arc cannot be controlled.

MR. LACHER: There are a few questions I would like to ask regarding this work. First, how long have frogs welded in this way been in use after welded? Second, how long does it take to weld one of them? Third, can it be done under traffic? Fourth, to what extent have manganese frogs been welded in this manner?

MR. JONES: One crossing of this sort at the entrance of our mill was welded eight months ago by Mr. Kincaid. The weld was done under traffic and the crossing is still in service and is subjected to very heavy traffic.

MR. WANAMAKER: The life of these welds has not been completely determined. One manganese weld on carbon steel which was put in last July is still standing up under the hardest kind of service. Another one that I know of which was made several months ago on a poor foundation still looks to be in good shape. It is a little bit too early to attempt to compile definite data, but it should be noted carefully that those who have used this process are disposed to continue using it. The cost of putting a special layout in good condition by this process is so low compared to taking the crossing out that the results obtained so far show that the process is worth while.

MR. GIERACH: Mr. Pennington used rolled rods having physical properties higher than cast rods. He also laid some stress on the matter of coating the rods. May I ask if these features are essential to the work?

MR. PENNINGTON: The function of the coating has been thoroughly borne out by experiment in experimental work. The material has "exploded" when coating was not used. The question of whether the rolled rods are better than cast is open to debate.

MR. GIERACH: A possible objection that I see to the coating is that the duration of the time during which the arc acts is not long enough for a reaction which would result in a complete separation of the foreign matter from the deposit steel.

MR. PENNINGTON: The training of the welder has something to do with this. Proper manipulation of the arc floats away the slag. It is true that the tendency for gas inclusion is greater with a coated electrode, but proper arc manipulation will prevent this.

MR. WANAMAKER: This is quite true. We have never noticed any slag inclusion in the welding when the arc was manipulated properly.

WELDING IN SHIP CONSTRUCTION

Editor:—

I was most interested in your article in the September issue of *The Welding Engineer* on "Welding in Ship Construction." The all welded ships built in this country are very well known in shipbuilding circles. I refer to number 3 and 4 under the subheading "Covered Electrodes." The electrodes in each of these cases being Quasi-Arc Electrodes.

On reading further under "Bare Electrodes," No. 5 is rather misleading. This small craft certainly was not an "all welded" boat. A full account of this early combination of riveting and barewire welding is to be found in "General Electric Review" December, 1918—pages 844-848 entitled "The First Electrically Welded Boat" by John Liston. The following is an extract from the article:—

"This boat the Dorothea M. Geary was built by its owner Mr. Frank Geary of the Geary Boiler Works, Ashtabula, Ohio. The keel, frames and deckhouses are riveted, but the seams of the hull and the fore and aft deck plates are electrically butt welded. . . . . When a few of the vertical welded seams were located between the frames, re-inforcing riveted straps were used. . . . . The hull plating as a whole was riveted to the frames and keel. The spacing of the frme rivets is shown in the lower part of Fig. 5."

The Dorothea M. Geary was built in 1915, but the sea-going lighter A. C. 1320, built at Richborough in a shipyard operated by the Inland Docks and Waterways Section of the Royal Engineers, and launched in June, 1918, was the first all welded ship.

I shall be pleased if you can find space in your journal for this correction which I venture to suggest will be of interest to your readers.

Naval Architect, October 5, 1921.

AUTOMOBILE WELDING

The Variety of Automobile Repair Jobs Is Constantly Increasing and This Work Can Be Made to Yield Good Profits

IT has been most truthfully stated "the job welder is a jack of all trades." But contrary to the old saying, he must be "master of all." In the automobile repair shop, the welder's qualifications are necessarily of a wide variety. Primarily, he must be an expert with the welding torch; there are no half-way measures about welding in the automobile shop. His other requisites include metal working, blacksmithing, tinning, etc.

Constant vibration and innumerable shocks to which the automobile is at all times subjected cause numerous failures in the frame, running gear, or power plant. The parts, so affected, vary as to composition and size. They may be of cast-iron, aluminum, malleable iron, or any one of the many alloyed steels or forgings which enter into the assembly of the car.

Long usage attended by abnormal abuse and very infrequent attention—especially failure to lubricate properly—results in wear and tear of important parts. Others become so firmly rusted into place that even the sledge-hammer and heavy drifts are of no avail in their removal.

It is the lot of the welder to contend with all these difficulties, and it is expected that he rectify them all, whether it be the repair of a bent or fractured chassis, the removal of a bushing which has resisted the mechanics efforts, the cutting out of rivets which cannot be reached with a chisel, and many others.

Once a welder begins to operate in the auto repair shop, the question invariably arises, "how did we ever get along without welding?" Undoubtedly the welding outfit must be classed as one of the very useful adjuncts in such a place. As a tool it serves so many purposes that it ranks above all other pieces of apparatus.

True enough, many shops operate without such an outfit. But they are handicapped greatly by the expense attached to sending out work, not forgetting the delay occasioned by such procedure. Furthermore, there are many occasions when it becomes impossible to send to the job welding shop for aid, although the use of the welding torch would reduce labor costs. Other methods must be resorted to, usually resulting in the pyramiding of expenses and long delays.

It is assumed, naturally, that the operator has the qualifications previously mentioned. Familiarity with his apparatus, a knowledge of materials, ability to execute successful welds are prime requisites. Members of the "plasterer's union" and "1918 models" are generally classed as unsuitable for this type of work and should be barred from participation in automobile activities as much as from any other branch of welding outside of sheet metal or small production work.

A really capable man can save the first cost of the apparatus within an incredibly short period and realize a neat profit for the proprietor at all times thereafter. Also, being an auto mechanic, he can find enough time between welding jobs to perform ordinary repair work, so that, at no time can he be classed as "burden."

The work which falls to the welder in a repair shop may be classified under several general headings, as follows:

1—heating: for forging, expanding parts, straightening, riveting, annealing etc.

2—welding: fractured parts and building up worn members.

3—brazing: fractured parts and building up worn members.

4—miscellaneous: decarbonizing repairing scored cylinders, soldering, tinning, and miscellaneous cutting such as plate work, rivets etc.

Although local heat may be applied by the use of several methods—forge, fuel oil preheater, blowtorch, or charcoal fire—there is no simpler means, nor one so convenient as the oxy-acetylene torch. At first hand its use may appear to entail a higher cost. Actually this is not true when balanced against the labor saved through its rapid action. The high temperature of the oxy-acetylene flame rapidly transmits its heat to the part to be worked so that the high charge which is usually allowed for a mechanic's time is minimized.

Bent chassis frames, steering knuckles, axles, shafts, etc. are examples of parts which can be readily repaired by heating with the torch and then straightening. Holes are easily drifted through spring leaves after heat has been applied in this fashion.

Formerly the idea was prevalent that only in a blacksmith's forge could an axle be handled properly. This impression has been discounted as a fallacy. Axles of the heaviest I-beam types can be handled successfully and very efficiently in the auto repair shop. Of course means must be at hand for proper alignment, but outside of this one requirement no special tools are needed. Two heavy wooden beams, a heavy sledge-hammer, the torch, and a straight-edge generally comprise the entire equipment, although a surface table would be an advisable addition.

For the straightening of heavy axles, the tip of maximum gas capacity is probably the most efficient for quickly heating the affected section. The volume of material in I-beam axles is generally large, and so distributed, that a large surface is provided for heat radiation. Protecting these surfaces with sheet asbestos to reflect the leak back to the axle is an economical procedure.

When riveting brackets to the frame or on similar work, the welding torch is a suitable source of heat supply, especially when the shop is not equipped with a forge, or even if so equipped, the forge is not operating at the time. On the other hand, the removal of rivets is facilitated by cutting off the heads, so that the shank of the rivet can be drifted out with a hammer. A special bent nozzle for the cutting torch can be obtained from apparatus manufacturers for this purpose. Sometimes a bracket has cracked but is still held loosely in place by the rivets. The addition of filler rod, or if a malleable casting is so concerned, the addition of tobin bronze rod suffices to remedy this faulty condition.

Hardly a day passes without there being at least four or five calls for some way of producing expansion. Either a stud is to be removed, or a bushing cannot be forced into place, or possibly a flange must be expanded so that it can be assembled and allowed to shrink to a force fit. It is remarkable how much manual labor can be eliminated by so simple an operation as the application of localized heat. Where mighty hammer blows would ordinarily fail to produce movement in assembling parts, expansion of the proper member permits very easy fitting together, with a certainty that upon cooling the part enclosed is held firmly.

Welding automobile parts calls for wide experience on the part of the welder. He must know metals. He must be an adept at producing results. Very often he must execute welds without the proper means for aligning or preparing the fracture, while at other times he must work in seemingly inaccessible places. His work is varied. One day he may have nothing but steel; another may bring only aluminum. Each and every job has its peculiar requirements. He must contend with steels which are generally alloyed and prepared by special heat treatments, requiring the use of proper filling rods and extreme care in handling under the intense heat of the torch flame.

Seasonal work is very noticeable in the auto shop. It is to be expected that cracked water jackets will be numerous during the

winter. Although the welding operation is in itself very simple, the handling of an automobile cylinder block during the preheating and annealing stages is a difficult matter. The cylinders are easily warped, or undue strains may be set up to result in fractures at a later time.

The power plant, running gear, and frame all yield work to the welder. Examples are so numerous that only a few need be mentioned; crank-cases, chassis, shafts, flanges, housing, brackets, rods, etc. There is hardly a part which cannot be reclaimed at a small actual cost compared to the cost of a duplicate where the latter can be procured. In the case of old and obsolete models, stock parts have become very scarce.

Malleable iron enters into the composition of the majority of automobile castings, especially those of small size. These must of necessity be brazed when fractured. However, it is not unusual for the welder to use steel filler rod, when the casting is very thin, with successful results. On some of the worn castings, it is also much simpler and cheaper to add a bronze filler and then finish by filing, rather than to weld with steel. This is especially true in parts where under normal operating conditions there is no wearing action, but, due to the loosening of a bolt or nut, movement has occurred and the friction has finally had its effect.

Under miscellaneous work has been noted several operations which really pertain to the welder. Familiarity with apparatus, and the fact that he appreciates better than the average auto mechanic the dangers arising from improper use of oxy-acetylene equipments, points him out as the logical person to handle the decarbonizing of automobile cylinders.

The filling of scores in cylinders is another type of work which the welder can perform advantageously, in that it requires considerable dexterity. There are many low-temperature preparations on the market for repairing such defects. Or if so requested by the customer the scores can be welded and the cylinders rebored.

It is not unusual, after a welder has been in such a shop for a short time, to have almost any difficult job thrown at him. To the other mechanics he seems to be a superman. He is expected to do the impossible. If, for example, a mechanic fractures a lug or bracket while assembling some member of the car, which may mean disassembling ordinarily, the welder is asked, "can't you stick it on someway, so it will hold?" Or a weld may be required close to the gasoline tank, and the mechanic will wonder why the welder refuses to undertake the work until the gasolene tank has been removed. He'd probably understand more readily if he once saw the results.

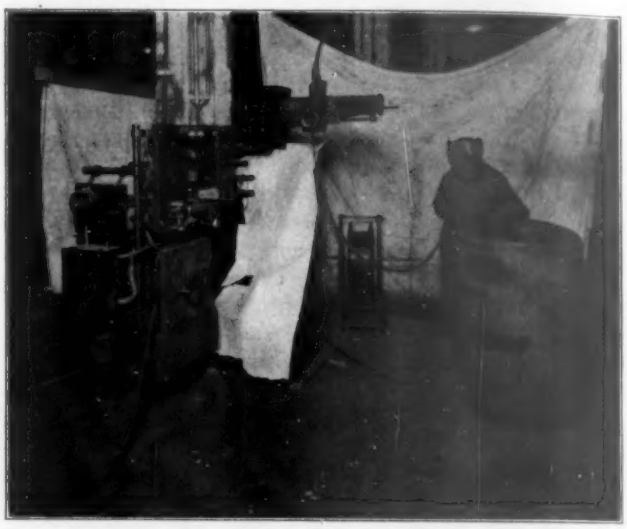
Several percautionary measures should always be taken in performing welding work in the auto repair shop. A chemical fire extinguisher and sand should be placed in a convenient place, easily accessible. No matter how careful the welder may be, there is a possibility of danger attending the use of the torch in a place where gasoline vapor is always present. Sheet asbestos should be used to cover oil-soaked parts, to protect the gasoline supply line when working on the car and when these parts have not been removed.

SEMI-AUTOMATIC ARC WELDING LEAD

A semi-automatic arc welding lead has just been developed by the General Electric Company, for use in conjunction with its automatic arc welding head, which retains the continuous features of the automatic apparatus, yet allows the operator to direct the arc as required by the conditions of the work.

The apparatus consists of a welding tool to be held by the operator, which acts as a guide for the electrode wire. In the handle of the tool, which greatly resembles an automatic pistol, is a switch for operating the control on the panel of the automatic welder to start and stop the movement of the electrode wire. Attached to the tool is a 10-foot length of flexible steel tubing, called the "flexible wire guide," with an adapter on the other end for attaching it to the automatic welding head. The wire passes from the feed rolls of the head into the flexible tubing, and thence to the arc through a "guide nozzle" in the welding tool. The automatic welder functions in its accustomed manner, tending to hold the arc length constant, and the operator merely directs the arc as required by the particular job in hand.

The field of application of the semi-automatic is the welding of products where the seams to be welded are of very irregular contour, or on very large work where the travel mechanism and clamping necessary for the full automatic welder would be complicated and costly. In many cases the edges of the seams



Operator Using New Semi-Automatic Lead.

are not accurately prepared, making gaps in some places, and tight fits in others. The automatic welder with mechanical travel cannot compensate for these conditions by varying the speed, or by manipulation of the electrode, but with the semi-automatic, they are taken care of.

The semi-automatic welder may also be used for building up metal rapidly, as in the case of the filling up of blow holes in castings, or the building up of worn spots, etc. The speed of deposition of the metal varies widely, being somewhere between the ordinary hand speed and that of the automatic, according to the conditions of the particular job.

The advantages claimed for the automatic welding equipment may be summed up as follows:

1st.—Saving in time which is ordinarily lost in changing electrodes.

2nd.—Saving of from 10 to 20 per cent in electrode material ordinarily thrown away as waste ends.

3rd.—Operators can become proficient in the use of the tool very quickly, as they do not require the muscular training necessary for hand work.

4th.—Continuous operation results in few interruptions in the welding, each of which is a potential source of defective welds.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION ANNUAL MEETING NEXT MONTH

The Compressed Gas Manufacturers' Association, representing practically every manufacturer of the various compressed gases in this country, Canada, Mexico and Cuba, will hold its Ninth Annual Meeting at the Engineering Societies Building, 29 West 39th Street, New York City, on Monday, January 16th, 1922, at 2 P. M.

The Ninth Annual Dinner of the Association will be served at the Manhattan Club New York City, at 7 P. M., of the same day.

The Compressed Gas Manufacturers' Association is one of the most representative large trade organizations in the country, representing more than 99 per cent of the compressd gas business of North America.

BRONZE CONDENSER SHEETS*

Gas Welding Gives Practical Solution of Problem Arising from Increase in Size of Ships

By H. I. Walsh†

THERE appeared in a recent issue of one of the marine journals an article giving a list of names and the tonnage of 570 sea-going vessels that were in San Francisco harbor on September 5, 1850. One of the things that struck me most forcibly in this list was the small size of these ships, and upon investigation I found that their average size was only two hundred and seventy-seven tons.

Seventy years in the history of shipbuilding is an extremely short time, and yet what a change has taken place! The ships that our yard is building at present run from about twenty

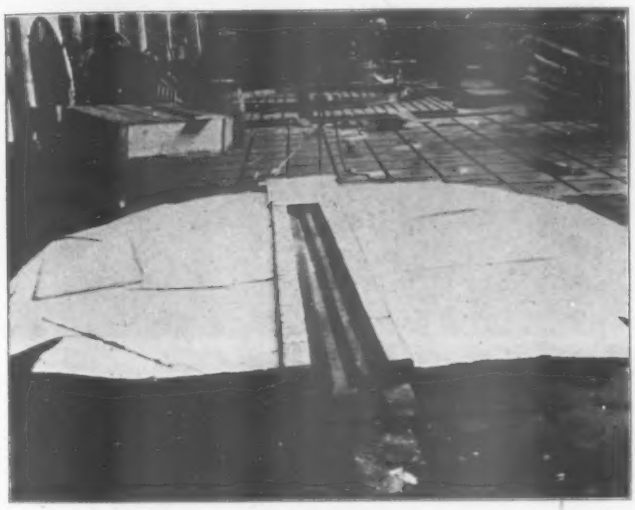


Fig. 1. Set-up for Welding Tube Sheets.

thousand tons for tankers up to thirty-two, forty and nearly forty-five thousands tons each for first line navy ships. With the sizes of ships increasing by such leaps and bounds is it any wonder that new processes and new methods must continually be devised for their building? It is impossible to say what single factor has made this vast increase in size possible, because so many factors have worked together, but there is one thing of which we may be sure, and that is that gas welding has done its part, and it has by no means been a small part.

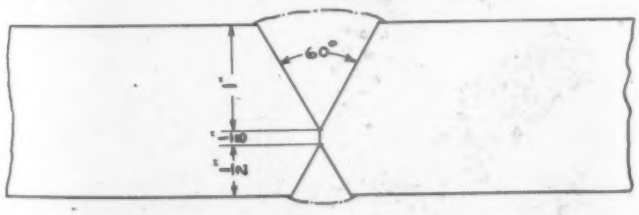


FIG-2

Method of Beveling First Sheet.

I have been asked to describe to you briefly one of the problems that we encountered as the size of ships increased, and our method of solving it. The increase in the size of ships was, of course, accompanied by an increase in the size of the propelling equipment, one part of which is the condensers.

About eight or ten years ago the size of condensers required for *battleships* had grown so large that it became impossible to impractical for the brass manufacturers to roll a plate thick enough and wide enough to make the tube sheet in a single piece. It thus became necessary to joint two pieces of brass to form a tube sheet.

This joining may be done by any one of three methods: scarfing and riveting, burning in the foundry, or gas welding. Our first method was to scarf and rivet, which was satisfactory after the sheet was installed, but due to the weakness of the joint in bending it was exceedingly difficult to handle the sheet in the shop. In 1919 we made an exhaustive test of the three types of joints with the following results:

Strength in Tensions:

Scarfed Joint	20	per cent of the strength of the plate
Burnt Joint	59½	per cent of the strength of the plate
Welded Joint	72	per cent of the strength of the plate

Strength in Bendings:

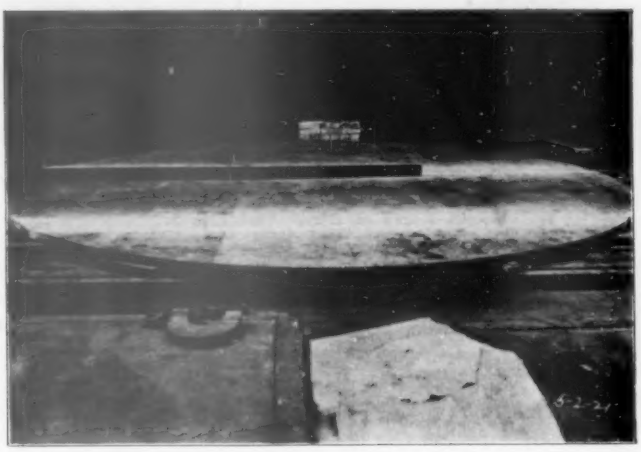


Fig. 3. Straight Edge Parallel to Seams Show ¾-Inch Warp Concave.

Scarfed Joint	10	per cent of the strength of the plate
Burnt Joint	27	per cent of the strength of the plate
Welded Joint	43½	per cent of the strength of the plate

Elongation:

Scarfed Joint	
Solid Material	49.3
Welded Joint	19.5
Burned Joint	25.4

We have no reliable figures showing the relative cost of burning and welding, since we never burned a complete plate. Our estimates, however, show that of the three methods, welding is considerably the cheapest, all things considered.

The welded joint was so much superior in every respect that it was decided to adopt that as our standard.

The first group of sheets that we were called upon to weld were 14.9 inches in diameter by 1⅝ inches thick, which I may say in passing are very large condenser sheets.

Figure 1 is a photograph of the "set up" for doing this welding. It will be noted that we have the entire sheet covered with sheet asbestos to reduce radiation as far as possible. Along the seam we laid up fire brick to form an oven to aid in the preheating. The preheating was accomplished by means of a hydrogen flame, and it was found that preheating should be started about one hour before welding, and the preheating torch kept well ahead of the welding torch all through the operation.

Our first sheet was beveled in two directions, as shown in

*Paper read at the International Acetylene Association Convention, October 4, 5, 6, 1921.

†Newport News Shipbuilding Co.

Figure 2, the included angle between bevels being approximately 60°. This seam was 14 feet 7 inches long. The sheets were so placed that the edges met at one end, while at the opposite end they stood apart 4⅞ inches. Upon welding up the seam it was found that the allowance for "pull-in" was too great, since the edges did not quite come together. On the next long seam the "pull-in" allowance was reduced to 4½ inches, which equaled 2.64 per cent of the length of the seam. This same ratio was held on the 11 ft. 5½ in. seams with perfect results.

With the double scarf it was, of course, necessary to turn the sheet over and weld up the second side. The welding of the first side of the double seam, when the plate was merely lying on the floor, free to expand and contract, corresponded, of course,

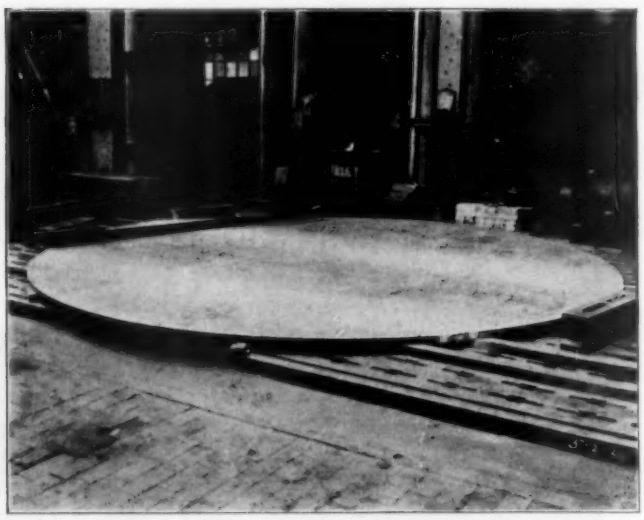


Fig. 4. Straight Edges at Right Angles to Seams Shows 1½-Inch Warp Convex.

to the non-rigid system of welding. As soon as the first side of the seam was finished the edges of the weld were no longer free to move, so that the welding of the second side corresponded to the rigid system.

When we first started to do the welding from both sides we anticipated some trouble, due to warping of the sheets, although we hardly expected it to be as serious as it proved. Photographs (Figures 3 and 4) were taken with a straight edge on the plate to show how it warped.

With the straight edge lying parallel to the seam, as in Figure 3, the plate is shown to be warped about three quarters of an inch, concave. In Figure 4 the straight edge was laid at right angles to the seam and showed a warping of approximately one and one-half inches, convex. This latter measurement was taken

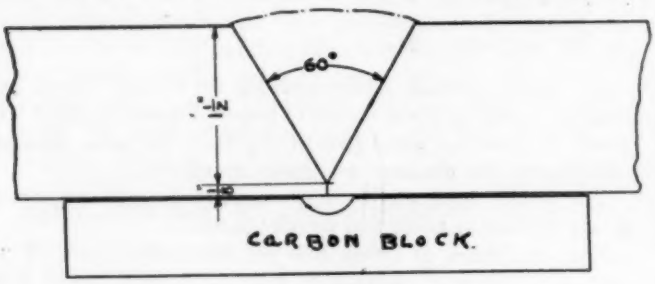


FIG. 5

Beveling for Short Seam.

with one end of the straight edge resting against the plate and with the other end in the air. Had the plate been turned over so that the concavity could have been measured in each case, it would have been found that the warping was approximately the same in each direction. The cost of straightening this sheet was greater than the cost of the welding, and in addition to this it required twenty hours for a workman to chip and clean out the second side before the welding could be started.

When welding the shorter, or 11 ft. 5½ in. seam, on this same sheet, we beveled it from one side only, as shown in Figure 5.

Upon completing this single side weld, it was found that the sheet remained perfectly straight, so all subsequent welds have been made in this way. After planing off the excess metal there were no porous spots to be seen, nor was there any appreciable difference in the color between the material in the plate and that in the weld. So far as the metal in the welds was concerned, that in the double weld was as good as that in the single weld.

Figures 6 and 7 show seams welded from one side and from two sides, respectively.

After planing off the excess metal an analysis was made of

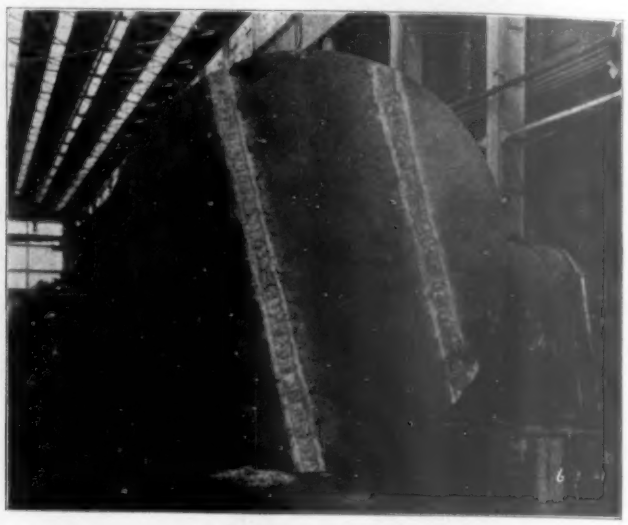


Fig. 6. Seams Welded.

the plate material, the material machined from the weld, and the Tobin bronze welding rod, with the following results:

	Copper	Tin	Lead	Zinc
Plate Material	57.37	.92	.....	41.71
Material Machined from Weld	61.20	.78	.....	38.02
Bronze Welding Rod	60.50	.63	.....	38.87

Fig. 7. Welds Opposite Figure 6.

The material used in welding the first four seams was as follows:

Length of Weld Style	Bronze Lbs.	Oxygen Cu. Ft.	Acetylene Cu. Ft.	Hydrogen Cu. Ft.	Welding Hours	Labor Hours
Two Seams 14 ft. 7 in. and 11 ft. 5½ in. Double	220	3,350	1,300	32,000	32	40
14 ft. 7 in. Single	155	1,900	754	6,000	9	20
11 ft. 5½ in. Single	127	1,600	740	4,200	8	18
Total Second Sheet	282	3,500	1,494	10,200		

Plates 12 ft. 8 in.

(Continued on page 40)

A. S. M. E. BOILER CODE

Preliminary Draft of Rules for the Construction of Unfired Pressure Vessels, with Rules for Welding

The following preliminary report on rules for the construction of unfired pressure vessels, with suggestions respecting rules for welding and brazing was presented for discussion by the American Society of Mechanical Engineers at a public hearing, Monday, December 5th, at the Engineering Societies Building, New York City:

The object of the hearing was to obtain the co-operation of everyone interested in the preparation of a Code for the Construction of Unfired Pressure Vessels and particularly that part of the Code which deals with welding and brazing. In order that the discussion might bear on specific points, preliminary drafts of rules for welding and brazing were presented. These drafts were suggestive only and were submitted as a basis for constructive criticism and in the hope that additional material will be furnished to assist in making good specifications. It is not the intent to restrict the work too closely by outlining specific methods to an extent that may eliminate other methods that are equally good or better, but, as far as possible, to establish certain fundamentals applicable to any method.

The Sub-Committee of the Boiler Code Committee on Air Tanks and Pressure Vessels requests all those interested to take part in the discussion and to present data in manuscript form, which will be carefully considered and digested by the Committee before making a preliminary draft of a complete Code for the consideration of all interested. In preparing this Code, it will confer with the Sub-Committee on Welding of the Boiler Code Committee, the Welding Conference Committee of the American Welding Society, the Welding Committee of the American Society of Refrigerating Engineers, and any other committee or organization interested. It will also be pleased to receive data and suggestions in manuscript form after the hearing and it earnestly hopes that the help and support necessary to make the Code a success will be forthcoming.

A. S. M. E. BOILER CODE
Part I—Section IV

Preliminary Report on Rules for the Construction of Unfired Pressure Vessels[1]

NOTE: When this section is incorporated in the Boiler Code, it will be desirable to add the words: AND OTHER PRESSURE VESSELS, at the top of front cover and of the title page, and on page 3 of the Code. Also the sentence in italics on page 3 will be changed to read as follows:

These rules do not apply to boilers and other pressure vessels which are subject to Federal inspection and control.

Also to insert, after bracket in line beginning Part I, the following:

SECTION IV—UNFIRED PRESSURE VESSELS

DEFINITIONS

1. The vessels to which these rules apply are divided into two classes:

CLASS A—Vessels for containing liquids above the atmospheric boiling point, inflammable substances, or any gas, and limited in size to those over 6 in. in diameter, more than 1.5 cu. ft. in volume and carrying over 15 lb. pressure per sq. in.

CLASS B—Vessels for containing liquids, the temperatures of which are under control so as to be below atmospheric boiler point and limited in size to those over 9 in. in diameter, more than 4 cu. ft. in volume and carrying over 30 lb. pressure per sq. in. but not to exceed 100 lb. pressure per sq. in. For pressures over 100 lb. per sq. in. the rules Class A vessels apply.

[1]Pars. 1 to 17 constitute a report presented for discussion at a public hearing held May 25, 1920, at the spring meeting of the society at St. Louis, Mo., and revised.

MATERIAL

2. These vessels may be constructed of any metal complying with the following rules:

The maximum allowable working stress used in any of the metals selected shall be determined by the following formula:

For Class A Vessels:—

$S = 0.0125\ E\ (e + 8)$, but not more than $0.4\ E$, or $0.2\ T$.

For Class B Vessels:—

$S = 0.0125\ E\ (e + 16)$, but not more than $0.65\ E$, or $0.25\ T$.

Where S = Maximum allowable working tension stress, lb. per sq. in.;
E = Elastic limit of material used;
T = Tensile strength of material used;
e = Elongation of material used, in per cent, in 8 in.

Working stress in rivets in single shear shall be taken as 80 per cent of S;
Working stress in rivets in double shear shall be double that of single shear.

3. Staybolt values for allowable stress per sq. in. of net section shall be taken as follows:

When e is not over 10 per cent = 60 per cent of S;
When e is from 10 to 20 per cent = 70 per cent of S;
When e is over 20 per cent = 80 per cent of S.

4. Class A vessels may be constructed of materials specified in the A. S. M. E. Boiler Code (Edition of 1918), in which case the formula above given need not be used.

5. Class A vessels shall be built in accordance with the rules of construction, which apply, of the A. S. M. E. Boiler Code (Edition of 1918) except Par. 186, which shall read as follows:

The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 per cent of the tensile strength of the plate.

and Par. 269 to 328, inclusive.

6. Class B vessels may be constructed of material specified in the A. S. M. E. Boiler Code (Edition of 1918), in which case the formula above need not be used.

7. For Class B vessels, steel of untested tank quality may be used, assuming the tensile properties below:

Tensile strength, lb. per sq. in.	48,000
Yield point, per sq. in.	25,000
Elongation in 8 in.	20 per cent

8. All Class B vessels shall be constructed in accordance with the rules of construction, which apply, of the A. S. M. E. Boiler Code (Edition of 1918), with the following exceptions:

Par. 180—Change FS = 4.

Par. 186—Rewrite as follows:

The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 per cent of the tensile strength of the plate. The ultimate strength of a joint which has been properly welded by the Autogenous process may be used in lass B pressure vessels only and shall be taken as 50 per cent of the tensile strength of the plate.

Par. 187—Change 36 in. to 48 in.

Par. 188—Change 36 in. to 48 in.

Par. 190—Omit entirely.

Par. 195—Change formula as follows:

$$t = \frac{6 \times P \times L}{2 \times TS}$$

Par. 210—Holes may be punched full size.

Par. 253—Rewrite as follows:

All rivet holes may be punched full size.

Par. 254—Omit entirely.

Par. 256—Omit entirely.

Par. 257—Rewrite as follows:

Calking should be done with a round-nosed tool.

Par. 262—Rewrite as follows:

Manhole plates may be of wrought steel, steel castings or of cast iron.

Par. 263—Omit entirely.

Pars. 269-328—Omit entirely.

9. *Drain or Blow-off.* No drain or blow-off shall be less than ¾ in. pipe size.

10. *Safety appliances.* All pressure vessels shall be provided with such relieving, indicating and controlling devices as the industry in which they are employed or use to which they may be put shall require to insure their safe operation. All such devices shall be so located and installed that they cannot possibly be rendered inoperative. The relieving capacity of safety valves shall be such as to prevent a rise of pressure in the vessel of more than 6 per cent above the maximum allowable working pressure.

11. *Supports.* All vessels must be so supported as to equally distribute the stresses arising from the weight of the vessel and contents. Class A vessels must be so arranged that the entire interior and exterior of the vessel may be thoroughly inspected. In the case of vertical vessels, the bottom head, if dished, of cylindrical vessels must be with the pressure on the concave side to insure complete drainage.

12. Lugs or brackets[1], when used to support a vessel of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on steel or iron rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Fars. 15 and 16 of the Boiler Code.

13. *Corrosive Chemicals.* All pressure vessels which are to contain substances having a corrosive action upon the metal of which vessel is constructed should be designed for a pressure in excess of that which it is to carry to safeguard against early rejection.

14. Class A vessels shall be stamped in accordance with the A. S. M. E. Boiler Code (Edition of 1918), Pars. 331-332.

15. Class B vessels shall be stamped in accordance with the A. S. M. E. Boiler Code (Edition of 1918), Pars. 376 and 377.

A. S. M. E.
B

16. *Location of Stamps.* Location of tank manufacturer's stamps to be as follows:

Plain cylindrical tanks, and all other tanks not of a steam boiler type shall have at least one stamp, all stamps to be plainly visible when the tank is completed.

On a tank with a manhole, said stamps shall be close to the manhole opening.

On a tank without a manhole, close to the handhole.

On a tank without either manhole or handhole, in a conspicuous place.

17. The tank builder's stamp shall not be covered by insulating or other material.

[1]From Par. 325 of Section 1 of the A. S. M. E. Boiler Code.

PRELIMINARY DRAFT OF RULES FOR WELDING AND BRAZING

SUBMITTED FOR DISCUSSION AT THE HEARING SET FOR DECEMBER 5, 1921, AND SUGGESTIVE ONLY

18. In issuing this mater for discussion, he Boiler Code Committee desires to bring out the fact that there is no way of determining the exact quality of a weld other than making a test to destruction. Tests can be made by an experienced person that will establish the safety of a weld-

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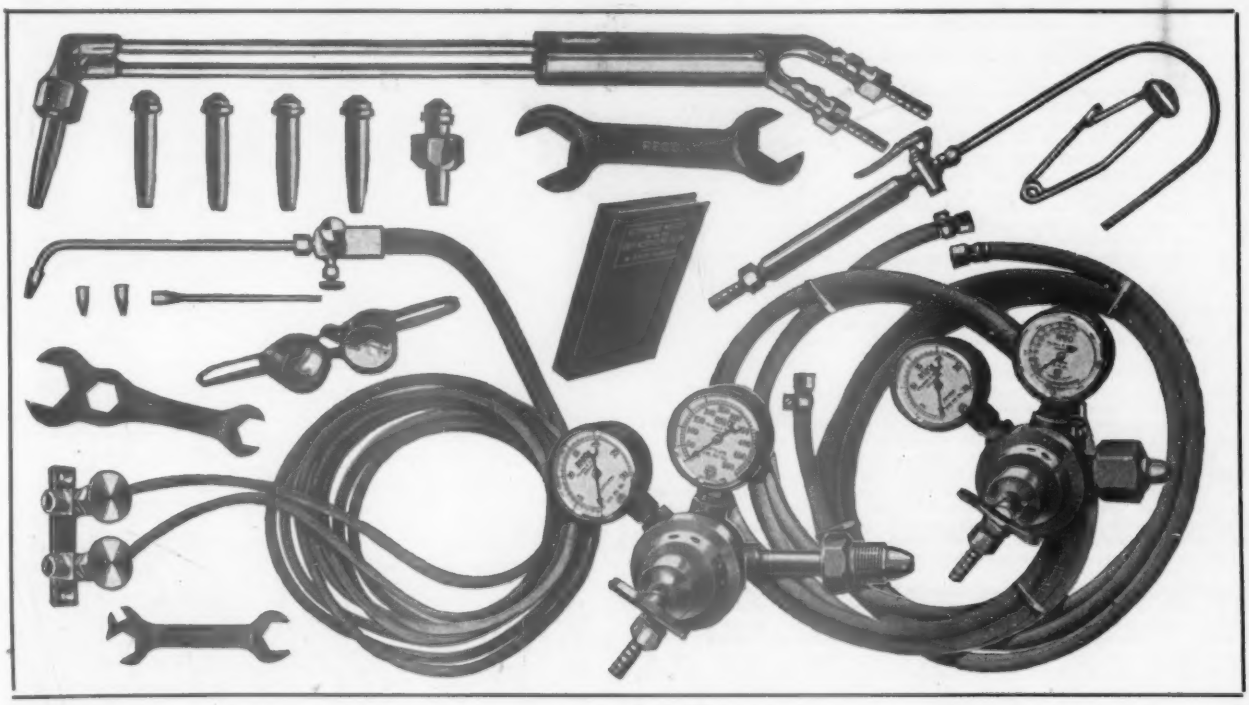

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1 new style REGO MT combination cutting and welding torch with 5 copper welding tips and 1 cutting tip for welding up to 3/4" steel and cutting up to 1" steel. ***PRICE $30.***

1 new style REGO B lead and sheet metal welding torch with 3 standard tips and 1 special tip 3" long for welding cracks in auto radiators. ***PRICE $5.***

1 REGO DS decarbonizing torch for removing carbon from auto cylinders. ***PRICE $3.***

2 2-gauge regulators, hose, spark lighter, wrenches and carrying case.

No garage, repair shop or service station is complete without this outfit.

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WEST AUSTIN AVENUE AT LA SALLE STREET CHICAGO.

ed pressure vessel within a reasonable doubt, but there is no absolute measure of the strength of the weld. That certain welds are safe is well established, but all depends on using the method of welding suitable for the service and on the skill and ability of the workmen and the care with which the work is supervised and tested.

19. With the above in mind, it can be seen that the safety of a welded structure depends upon the manner in which the work is done and on the care taken by the manufacturer to secure good work. It has been suggested that the manufacturer of a welded structure should in all cases be held responsible for its safety when used under conditions for which it was designed. Even should it be possible to make tests to establish the absolute strength of a weld, these tests would in most cases be made by the manufacturer or his agent, and the user would look to the manufacturer for safety. The Boiler Code Committee would be pleased to receive suggestions as to the best way of placing the responsibility for any welded structure on the manufacturer. Possibly the manufacturers might be required to guarantee the tanks which they make against accident and property risks.

20. It is proposed that all tanks and pressure vessels built in accordance with the code be marked with the name of the manufacturer, so that their source will be clearly indicated. It is further proposed that vessels built in accordance with the Unfired Pressure Vessel Code will be stamped with the A. S. M. E. symbol for such vessels, and the manufacturer obtaining the stamps for impressing the symbol will enter the same contract now required for the stamp used for power boilers, namely, that a stamp will not be misused and that it will be returned on demand to the Boiler Code Committee.

21. The features covered in the preliminary draft of rules for welding and brazing are limited to methods to be employed, the form of joints and the materials to be used. The rules in the Code for Air Tanks and Pressure Vessels apply to the general construction of the tanks and would be followed in all cases unless exceptions are made in the rules for welding and brazing. Certain features, such as the joint efficiencies to be employed are omitted from the rules and a list of questions follow the rules bearing on these features. These questions will be discussed one at a time at the hearing. In discussing these questions the Boiler Code Committee requests that scientific data and facts be submitted, preferably in manuscript form, with a summary giving contents and conclusions.

22. It is proposed in the case of autogenous welding to divide the vessels into three groups:

GROUP 1. Vessels in which autogenous welding may be employed; where the safety of the structure depends on the strength of the autogenous welds.

GROUP 2: Vessels in which autogenous welding shall not be used for carrying the strain, and where the safety of the structure shall not be dependent upon the autogenous welding.

GROUP 3: Autogenous welded vessels in which an agreement cannot be reached as to whether they should be placed in Group 1 or in Group 2.

23. It is proposed that the rules shall not prohibit the use of autogenously-welded vessels included in Group 3, but that such vessels shall not be marked with the A. S. M. E. Code symbol. The responsibility for the safety of vessels in Group 3 would then fall solely on the manufacturers and users, and the case they are installed in a state or municipality having adopted the code, the responsibility for their safety would also fall on the state or municipal inspectors who accept them for service.

24. Autogenous welding is comparatively new, and if the above grouping is adopted, it is possible that there will be vessels included in Group 3 which in time will be shown to be safe for inclusion in Group 1; until such time, the vessels may be used with the understanding that they shall not be stamped with the code symbol. It should not be inferred that a vessel placed in Group 2 must necessarily remain in that group, as experience may demonstrate that it will be advisable to make changes, which can be done at any revision period. The Boiler Code Committee recognizes the advance that is being made in autogenous welding and wishes to encourage progress and improvement. Advance should, however, be made in a way that will not endanger life or property, and it is the duty of the Boiler Code Committee in issuing any rules to make sure they are safe. It would seem highly desirable to lean toward the side of safety in bringing out rules for a new and growing industry, with the idea of broadening out the rules as the art advances, rather than to reach out too far at the start with the risk of accidents that might set back its development.

25. Autogenous welding may be used on any vessel for making tight joints where it is not relied on for strength, in which case the requirements of the code for stationary power boilers would apply, these requirements being as follows:

Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the reuirements of the code and where the safety of the structure is not dependent upon the strength of the weld.

26. Forge welding is an old art, and forged constructions have been safely used in many vessels where the main strains are carried by the welds. Notable instances of severe service in forge welded pressure vessels are in oil-cracking stills and autoclaves where, in addition to carrying the main strains, the steel is brought to a high temperature. It would therefore seem that forge welding should be allowed under proper restrictions for all classes of vessels, and for all pressures.

PROPOSED GROUPING OF AUTOGENOUSLY WELDED VESSELS

GROUP 1

27. Vessels in which autogenous welding may be employed where the safety of the structure depends on the strength of the autogenous welds.

Air tanks in which the pressure does not exceed 130 lb. per sq. in., or some other figure to be decided on.

Tanks for containing gases, other than noxious or explosive gases, in which the pressure does not exceed 130 lb. per sq. in., or some other figure to be decided on.

Tanks for containing liquids (at temperatures not exceeding their boiling point at atmospheric pressure), other than those which are noxious or explosive at pressures not to exceed 130 lb. per sq. in., or some other figure to decided on.

Circumferential seams of all vessels other than those in Group 2.

Inlet and outlet connections for all tanks other than those in Group 2.

GROUP 2

28. Vessels in which autogenous welding shall not be used for carrying the strain, and where the safety of the structure shall not be dependent upon the autogenous welding.

Pulp digesters;
Rendering tanks;
Air storage vessels for diesel engines;
Oil stills and pressure tanks used in the distillation of oil;
Autoclaves;
Brick-drying cylinders;
Creosoting cylinders;
Steam receivers and separators;
Longitudinal seams to pressure vessels containing noxious or explosive gases, or noxious or explosive liquids.
Longitudinal seams of pressure vessels having a thickness of shell plate of over 5/8 in.

GROUP 3

29. Autogenously welded vessels, in which an agreement cannot be reached as to whether they should be placed in Group 1 or Group 2.

It is hoped to make this group as small as possible, or better still, to have no vessels in this group.

PRELIMINARY DRAFT OF RULES FOR UNFIRED PRESSURE VESSELS WELDED BY AUTOGENOUS PROCESS

(Suggestive Only)

30. *Processes.* The autogenous process, so-called, shall consist of welding by means of either the oxy-acetylene process or the electric arc process, using a metallic electrode, either bare or covered.

31. *Design and Construction.* The design and construction of welded vessels under this code shall in all cases conform to, and shall be based upon the formulae, specifications and data which are given in the Code for Unfired Pressure Vessels unless some special requirement is necessary because of welding, in which case the requirement shall be specifically detailed in this code.

32. *Terms.* The term *base metal* as used in this code shall mean the metal or metals of which the vessel is constructed, and which are joined together by the welded seam.

33. *Filling Material.* The term filling material as used in this code shall mean the weld rod, filling rod, electrode or other metal which is used to join together two sections of the base metal, or metals. The following filling metal has been shown to give acceptable results:

FOR OXY-ACETYLENE WELDING

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent

Carbon	0.18 to 0.22 per cent
Manganese	0.40 to 0.50 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent
Nickel	3.0 to 3.5 per cent

FOR ELECTRIC ARC WELDING

Carbon	not over 0.06 per cent
Silicon	not over 0.08 per cent
Manganese	not over 0.15 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent

Carbon	0.12 to 0.18 per cent
Silicon	not over 0.06 per cent
Manganese	not over 0.40 to 0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.04 per cent

The filling metal must be clean, flow freely, and shall neither "spit nor spark" appreciably during welding. Its fusing temperature shall be such as to correspond relatively with that of the sheet, or base metal. The size of the wire and the size of the tip shall be such as to enable the welder to meet the conditions required by the work he is doing with oxy-acetylene welding, and the size of the electrode and current characteristics should meet these same conditions for electric-arc welding.

34. *Weld metal.* The term *weld metal* as used in this code shall mean the metal of which the welded seam is composed after welding is completed, and which is described as being the metal deposited between the edges and for the purpose of joining the sections of the base metal. This metal may be, and usually is, a combination of base metal and filling metal, modified in the process of fusing.

35. *Material for Base Metal.* The base metal composing the shells of unfired pressure vessels under this code shall be made by the open hearth process, of soft and good weldable quality, and shall conform to the following requirements:

CHEMICAL PROPERTIES AND TESTS

36. *Chemical Composition:*

Carbon by combustion test	not over 0.15 per cent
Manganese	not over 0.60 per cent
Phosphorus	not over 0.05 per cent
Sulphur	not over 0.04 per cent

The silicon, nickel or chromium content shall not be of such amount as will affect adversely the welding qualities of the plate, and in any event shall not exceed 0.05 per cent.

37. *Analysis.* A ladle analysis of each melt of steel shall be made by the manufacturer to determine the percentage of the important elements, carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pour of the melt. The chemical composition thus determined shall be furnished the purchaser, or his representative, and shall conform to the requirements as spectfied.

PHYSICAL PROPERTIES AND TESTS

38. *Tension Tests.* The base metal shall conform to the following requirements:

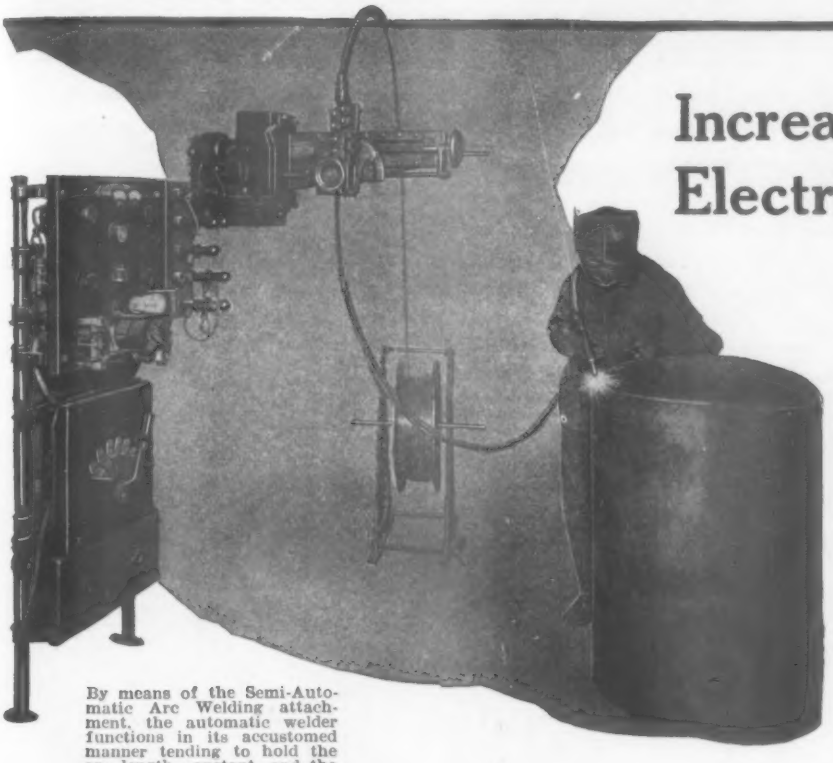
Tensile strength in lbs., per sq. in.		45,000-55,000
Yield point, min., lb. per sq. in.	minimum	0.5 Ten. Str.
Elongation in 8 in., min., per cent		1,500,000 / Ten. Str.

39. *Test Specimens, Bend Tests, Finish, Etc.* The test specimens, bend tests, homogeneity tests, number of tests, permissible variation in gauge, finish, marking inspection, rejection, and method of computing the maximum allowable working pressure shall conform with the requirements of the A. S. M. E. Boiler Code, Section I. for Power Boilers.

40. *Method of Welding.* Seams or joints may be welded on both sides by the double-V method, so-called, or on one side only with a single-V, using the butt strap method in which the butt strap is tacked clear of the sheet at least 1/16 in., or by such other method as will assure the joint being filled with sound metal, thoroughly fused, and to a thickness in excess of the maximum thickness of the plate, not less than 10 per cent nor more than 15 per cent.

There shall be no valley either at the edge or in the center of the joint, and the weld shall be built up so that the welded metal shall present a gradual increase in thickness from the surface of the sheet to the center of the weld. At no point shall the sheet on one side of the joint be off-set with the sheet on the other side of he joint in excess of one-quarter of the minimum thickness of the sheets or plates.

41. *Longitudinal Joints.* Where vessels are made up of two or more



By means of the Semi-Automatic Arc Welding attachment, the automatic welder functions in its accustomed manner tending to hold the arc length constant, and the operator merely directs the arc as required by the particular job.

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Advantages

Saves time ordinarily lost in changing electrodes.

Saves 10% to 25% in electrode material ordinarily thrown away as waste ends.

Operators learn to use it quickly, as they do not require the muscular training for hand welding.

Continuous operation results in few interruptions in the welding, eliminating a source of defective welds.

This new G-E device can be attached to any G-E Automatic Arc Welding head in such a manner that the electrode wire passes from the feed rolls into the flexible tubing and thence to the arc through a guide nozzle in the welding tool.

Automatic electrode feed—hand work

The G-E Semi-Automatic Arc Welding Lead is a device to be attached to the G-E Standard Automatic Arc Welder which obtains the continuous welding features of the automatic welder, and permits the operator to direct the arc as required by the conditions of the work.

This new device consists of a welding tool to be held by the operator, which acts as a guide for the electrode wire. In the handle of the welding tool there is provided a switch for operating the control on the panel of the Automatic Welder. Attached to the welding tool is a 10-ft. length of flexible steel tubing (called the flexible wire guide) with an adapter at the other end for attaching it to the automatic welding lead.

By means of this attachment the operator can work on products where the seam to be welded is of very irregular contour, or on large work where the clamping and travel mechanism for full automatic welding would be complicated and costly.

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cylinders the welded longitudinal joints of adjacent sections shall be 180 deg. apart.

42. *Distortion.* The cylinder, or barrel of a vessel shall be true to form within the limits of one-quarter of the thickness of the plate, and to meet these specifications the cylinder, or barrel, shall be reheated, re-rolled or reformed as may be necessary to bring it within these limits.

43. *Dished Heads.* Dished heads convex to the pressure shall have a skirt not less than 3 in. long and shall be inserted into the shell with a driving fit in excess of the full length of the skirt, welded to the shell with a V'ed weld, heated to the annealing point, and constricted on the end to a diameter not less than 1 in. smaller than the shell diameter.

Dished heads concave to the pressure shall have a skirt not less than 3 in. long.

44. *Spherical Heads.* Spherical heads concave to the pressure shall have a skirt not less than 1 in. long.

45. *Nozzles.* Nozzles in heads or shell over 3 in. and not to exceed 8 in. nominal size, shall be of forged or rolled steel, with a flared skirt. These nozzles shall have a forged, rolled or Van Stone flange for pipe connections.

46. *Nipples.* Nipples or couplings over 2 in. and not to exceed 3 in. nominal pipe size shall be inserted from the inside through the sheet or plate, shell or head to a flange or shoulder and welded thoroughly from the bottom of the V'ed shell plate and with a filet, as shown in Fig. 1. The thickness of the nipple or coupling wall and shoulder shall be not less than extra-heavy pipe-size standard. Nipples of this type smaller than 2 in. may conform to this same construction.

Threaded nipples 2 in. nominal pipe size and under may be made of extra heavy steel pipe or steel tubing, with corresponding thickness of wall, inserted in a hole with V'ed edges in the shell or head, and welded full with a fillet as specified before in this paragraph and as shown in Fig. 1. Threaded connections for pipes 2 in. and under may be made by using an extra-heavy pipe size coupling inserted in a hole with V'ed edges in the shell or head and welded full with a fillet as before specified for nipples of like size and shown on sketch. Threaded connections for pipes 2 in. and under may also be made by building up a boss of filling metal, thoroughly fused to the plate or sheet, and then drilling and tapping through both boss and sheet; the outside diameter of the boss shall be not less than the outside diameter of the boss of an extra heavy cast fitting of like pipe size. The height of the boss and tapping shall be such that when a nipple is screwed into place the inner end of the nipple, which shall have the full number of threads, shall be at least flush with the inner surface of the plate or sheet.

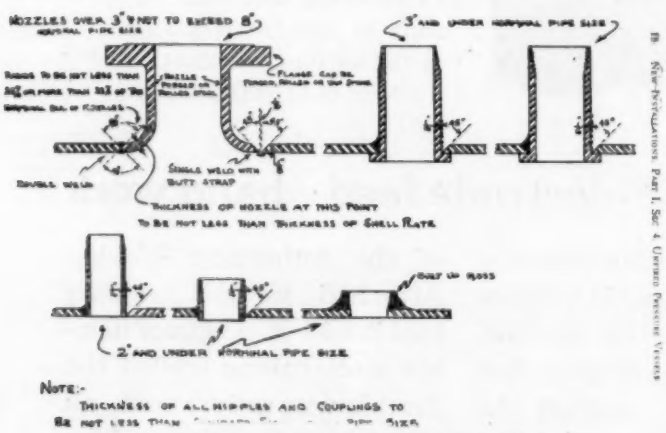

NOZZLES OVER 3" & NOT TO EXCEED 8"
3" AND UNDER NOMINAL PIPE SIZE
DOUBLE WELD
SINGLE WELD WITH BUTT STRAP
THICKNESS OF NOZZLE AT THIS POINT
TO BE NOT LESS THAN THICKNESS OF SHELL PLATE
2" AND UNDER NOMINAL PIPE SIZE
NOTE:-
THICKNESS OF ALL NIPPLES AND COUPLINGS TO

Fig. 1. Recommendations for Welding Nipples

47. *Hydrostatic Tests*: Vessels with seams or joints made by the autogenous process shall be subjected to a hydrostatic test of at least 1½ times the working pressure for which the vessel is designed, and while subject to this pressure shall be given a thorough hammer, or impact, test. This impact test shall consist of striking the sheet on both sides of the welded seam a sharp vibratory blow with an 8 to 10 lb. hammer, with a handle similar to a blacksmith's striking hammer, the blows to be struck 2 to 3 in. apart and within 2 to 3 in. of and on each side of the seam—the blows to be as rapid as a man can conveniently strike a sharp, swinging blow, and as hard as can be struck without indenting or distorting the metal of the sheet. During this test the shell shall be thoroughly filled with water.

48. *Defective Welds.* Welded seams, or joints, which do not pass this test without leaks, distortion or other signs of distress shall not be accepted until the defects are remedied and a further test applied which shall be successfully passed. Defective sections of a welded seam may be cut out and rewelded provided the value of the sheet has not been definitely lowered, and where this shall be brought into question a coupon shall be cut out across the weld at the point or points in question and subjected to microscopic or other examination.

49. *Stamping.* Vessels constructed under this code shall be stamped in accordance with the stipulations provided in the Code for Unfired Pressure Vessels.

50. *Inspection.* Inspection shall be made in accordance with the stipulations provided in the code for unfired pressure vessels.

QUESTIONS TO BE SUBMITTED FOR DISCUSSION AT HEARING

1. Shall autogenously welded joints be annealed?
2. Shall autogenous welding on both sides of the plate be specified in Par. 12 of the longitudinal seams of Class A vessels, and a single V weld be prohibited for the longitudinal seams of Class A vessels?
3. What method shall be specified for attaching dished heads concave to the pressure, including spherical heads?
4. Will a satisfactory construction be secured by attaching a flanged nozzle in the manner shown in Figure 1?
5. Shall the lengths of shells of cylinders having longitudinal seams which are autogenously welded be limited to five diameters?
6. Should the filling metal for autogenous welds be such as to give, when properly deposited, characteristics which approach as nearly as possible the characteristics of the base metal?
7. Shall the code cover vessels used for ordinary hot water service such as range boilers and hot water tanks?
8. Shall a hydrostatic test of twice the working pressure be specified in Pars. 47 and 69 in place of 1½ times the working pressure?
9. Shall 130 lb. per sq. in. be used for limiting the pressure of air tanks, etc., included in Group 1?
10. Shall any modifications be made in the code rules to cover glass-enameled steel vessels?
11. Shall tanks with brazed joints be used for all pressures, provided they are used cold, or shall the pressure be limited?
12. What rules shall be used for electric pressure welding?
13. What rules shall be used for Thermit Welding?
14. What joint efficiency shall be specified for computing the maximum allowable working pressure by the code rules?
    a—For a joint autogenously welded by the oxy-acetylene process?
    b—For a joint autogenously welded by the electrical process?
    c—For a brazed joint?
    d—For an electric pressure welded joint?
    e—For a thermit welded joint?
    f—For a forge-welded joint?

DEMONSTRATES WELDING AT MINING SHOW

The Bastian Blessing Company, manufacturers of the well known Rego welding and cutting equipment, demonstrated its apparatus at booth No. 148, at the American Mining Congress, held in Chicago recently. Complete units for all ranges of work within the limits of the oxy-acetylene or oxy-hydrogen processes

Bastian Blessing Booth at Mining Show.

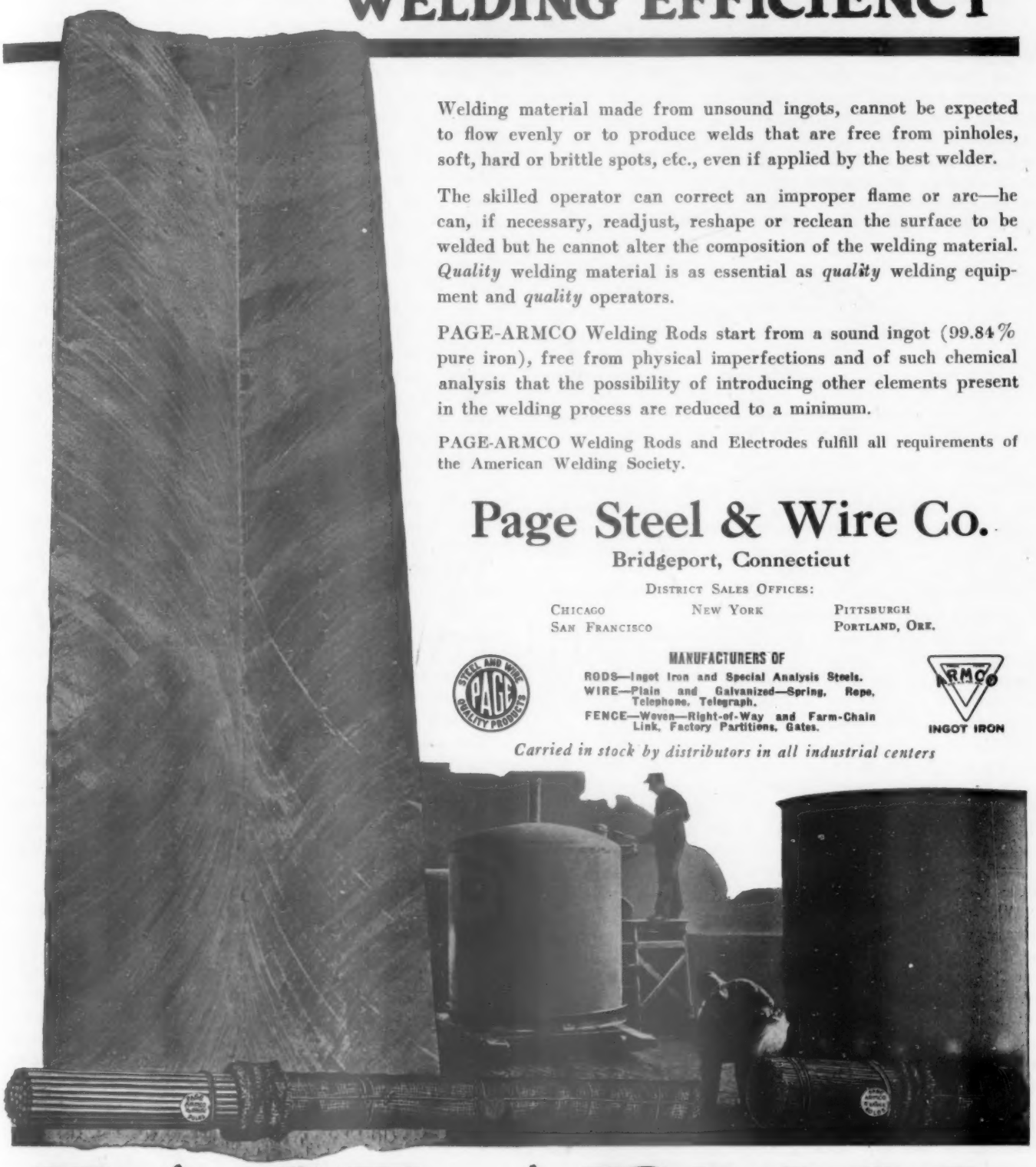
were shown. The torches were operated to show the automatic perfect flame adjustments and the non-flashback feature. The ladies were particularly interested in the toy balloons given away at the booth, which were filled with hydrogen gas.

GAS PRODUCTS ASSOCIATION BANQUET

The annual general meeting and banquet of the Gas Products' Association will be held in Chicago on January 20th and 21st, 1922. Papers and discussion concerning items of interest and problems pertinent to the hydrogen and electrolytic oxygen industry will form the major part of the program. All those who were in attendance at the annual meeting last year will remember the many interesting features on the program. The Secretary of the Association promises that the 1922 get-together will outshine all previous meetings, and that it will be agreed by those who attend, as time well invested.

Resistors for the welding of rail bonds is described in a bulletin being circulated among the welding trade by the American Steel & Wire Company. The resistors have been recently developed by the company.

SOUND INGOTS *and* WELDING EFFICIENCY



Welding material made from unsound ingots, cannot be expected to flow evenly or to produce welds that are free from pinholes, soft, hard or brittle spots, etc., even if applied by the best welder.

The skilled operator can correct an improper flame or arc—he can, if necessary, readjust, reshape or reclean the surface to be welded but he cannot alter the composition of the welding material. *Quality* welding material is as essential as *quality* welding equipment and *quality* operators.

PAGE-ARMCO Welding Rods start from a sound ingot (99.84% pure iron), free from physical imperfections and of such chemical analysis that the possibility of introducing other elements present in the welding process are reduced to a minimum.

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WELDING RODS and ELECTRODES

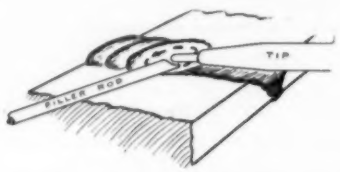
B R A S S W E L D I N G

Flame Manipulation Has Much to Do With Success or Failure of Welds Performed on This Metal

Denver, Colo., Thursday.

Dear Ed:—

Was pleased to learn that you found that kink on the Ford motor heads a help. I know for a fact that most of the welders have the same trouble you were having before you learned this new method of handling them. You don't owe me a darned thing Ed, I'm glad to help all I can. Just say "thank you" or "much obliged" once in awhile and that's all I'll ask. I suppose you are wondering what I'm going to write about this time. I won't keep you guessing any longer, it's about welding brass.



Position of Torch and Filler Rod for Welding Brass.

Was talking to the proprietor of one of the largest commercial welding shops here yesterday and picked up two or three pointers that if you don't know about may prove interesting. This particular shop gets quite a bit of the large welding work from the mines and from some of the pictures you could see that some mighty big jobs had been handled.

"Have you heard many welders complain about welding brass?" I was asked during the conversation.

"I can't say that I have, altho I've seen some pretty rough looking specimens," I replied. "As a matter of fact ninety-nine welders out of every hundred are the best welders alive, they don't hesitate in admitting it, and naturally won't concede a thing; but why do you ask?"

"Well, there's one metal that I seem to have trouble in getting my men broken in on. When you come right down to it, I take it that each of us sort of specializes on some sort of metal or another and my hobbie seems to be brass. I don't know whether it should be called a hobbie or not but anyway I'm particular about the way my brass welding is done."

"Does your procedure on the metal vary much from the ordinary methods?" I inquired.

"Why that all depends upon what you term ordinary. The average welder seeing me weld brass would positively state that it is identically the same method he uses but I'll tell you this, that if one of us holds his flame in contact with his metal at some critical point when the other holds his an inch away, there will be a marked difference in the resulting weld. It's the smallest details such as this that influence brass and the conditions involved in heating vary to such an extent that no fixed rules can be laid down. You probably see what I mean."

"I can certainly appreciate your stand but that's just what I'm looking for," I said. "I have a friend back east that is sort of "bugs" on welding so if I can give him just an outline of your personal experience I know he won't rest until he burns up a lot of gas and material figuring out your way of doing things. You had better touch the high spots for me anyway.

"Well, sir," he started, "it's a whole lot harder for me to tell you these things than to show you but if I happen to overlook anything that you think is important, just call my attention to it. Now, in speaking of brass we might just as well include the bronze family because they are first cousins. Brass has for its base, copper, and to this is added, zinc. It usually runs about two-thirds copper to one-third zinc while with bronze the percentage of copper is greater and besides the zinc a small quantity of tin is added. Now if the oxy-acetylene flame is turned on a piece of brass or bronze, naturally, the zinc melts before the copper, because of its lower melting point and gives off dense white fumes. If a weld is not properly made these fumes will deposit a heavy white coating on everything near the weld, including the welding torch. Not only that but the weld will look rough and will be weakened by the burning out of this alloy. By handling the flame in a certain manner which I will explain shortly, and using the right sort of filler-rod, much of this burning can be eliminated or corrected whichever you have a mind to call it. There are various grades of filler-rods a welder can use but the right kind of a bronze rod proves best, to my way of thinking. After you have your rods—"

"Pardon me a minute," I interrupted, "about these rods, how is a fellow to know when he has the right ones?"

"Oh, that's not very hard to tell. First of all be sure it's a drawn rod and not cast; next drop it on the floor, if it rings that's a good indication; then heat up one end to a cherry red and hammer it, if it crumbles up it's no good but if it forges well that's another good indication, after that it must flow nicely under the flame. Is that perfectly clear?" he asked.

"There's just one question," I answered, "why do you prefer a drawn rod to one that's cast?"

"You'll grant that welding is really a casting process," he went on, "only instead of pouring our mold all at once we might say that we melt in our metal a little at a time." I nodded so he continued. "To make that casting, I want virgin metal. I know I get it in the drawn rod but the cast rod may be cast and recast many times before it reaches me and I can't trust it."

Wishing to draw him out a little further I asked him what he thought of tobin bronze.

"Tobin is a good rod for welding but there are others I like just as well and some a little better. You see tobin is only a trade name for a bronze manufactured by one certain brass company, but at that it's rather interesting to follow some of these things through. You see for a long time the various brass companies were trying to figure out some way of making a brass or bronze that would forge at a red heat. They weren't very successful until one day this fellow Tobin bauled up the formula in making a regular run and after throwing the whole furnace charge in the scrap they discovered that it was the very mixture they were looking for and instead of being discharged Tobin had his pay increased and his name rolled on every rod thereafter. This happened long before gas welding was known but with the coming of welding it was found that this Tobin rod, made a pretty good filler-rod for brass and bronze welding so that now it's almost a byword with most welders. It's a good rod but as I have told you, there are others I like better."

"But to go on with the welding, I 'V' out along the line of weld leaving only an eighth of an inch at the bottom then I choose about the same size tip that I'd use for cast iron i. e.:— when the part to be welded is small I pick a small tip and when it's large I use a much larger one. Ordinarily a fellow would think that less heat would be required for brass on account of its lower melting point but its conductivity is so great that the larger flame is desirable. Whenever possible I throw a bunch of scrap asbestos paper in a pail of water, get it good and wet, and then pack it around the line of weld. This is to hold as much of my heat as possible at the weld. I use a good grade of flux which incidentally I do not make myself. I believe that

the manufacturers know more about what to put in a flux and what not to put in than I do and the cost is very small at any rate. When heating up my line of weld to a bright red heat I use a strong neutral flame but at that point I shut off both my oxygen and acetylene a little in order to get a softer flame. Then too, as a rule, I give the flame just a trifle more acetylene just so it shows a trace off of the neutral. I do this in order to be absolutely certain that there is no excess of oxygen as an oxidizing flame is about the worst condition that can exist when welding brass. With the part being welded at a bright red heat I remove the flame just along to sprinkle some flux on the line of weld, throwing it on with my hand. I bring back any flame and hold it with the end of the neutral cone just licking the metal until it commences to melt then I bring up my rod, the end of which I have already heated and dipped in the flux, and fuse it to both sides of my 'V' and at the same time melt the bottom of the 'V' all the way through. In this operation only enough filler is added to give a coating, as it were."

"Just a minute," I broke in, "if your weld is a long one, say about twelve inches from one end to the other would you coat the entire distance in this manner?"

"Not if it were that long," he continued, "I'd only coat about three or four inches at a time. Once the parts are coated and the bottom fused together then I change my tactics; turning my tip on its side I start at the beginning again and instead of playing my flame directly at my work I get enough heat off the side of my neutral flame to keep my metal in the proper condition, which should be just on the verge of melting. While doing this my flame is pointed backwards and not in the direction I'm working. Now my filler rod is brought in the direct path of the neutral flame and it flows in wherever desired. In this way the weld can be built up as much as you wish. There are just two points which I should like to call to your attention: —first, use plenty of flux, and second, after your metal has once 'set' don't melt it unless you add more filler when you're doing it."

"What will happen if you don't add more filler?" I asked.

"It will become rough and spongy looking," he answered, "whereas by adding the filler it will come out nice and smooth."

"In a way brass welding seems to be much like brazing," I remarked.

"It's much the same," he replied, "and while I think of it there's another point I'd like to emphasize, it's that coating of the 'V' that I mentioned. When this coating is made the filler should run over the surface just like water. This coating is just as important as the tinning process in soldering; unless a good foundation is laid, it makes no difference how much metal may be piled on top, it will never hold."

After that he went on to tell me about some of the large jobs he had done in the past and his methods of handling but methinks this ought to be pretty near enough for you in one letter so I'll ring off.

My next jump will be Salt Lake City. I've never been there but having heard much about the burg I'm sort of anxious to give it the "once over." Those Mormons must be a rare crowd but we'll soon see what's what and if the famous water in the Great Salt Lake don't get me and there's anything interesting comes in my way I'll drop you some sort of a screed from there. Don't think I'll be in Salt Lake very long so will give the Multnomah Hotel, Portland as my next address. Don't fail to write.

Yours, the same as ever

Shep.

BROKEN ARMATURE SHAFTS WELDED WITHOUT REMOVING OR INJURING COILS

Large armature shafts occasionally break at the junction of the journal and the pulley end. While recognizing the adaptability of the Thermit welding process to the welding of all kinds of large steel shafts, operators sometimes in this case decide to scrap the old shaft, fearing that the heat of the steel produced by the Thermit reaction might injure the armature coils and produce short circuits.

Where the armature coils, however, can be separated from the fracture by a few inches of molding sand (at least about 4 inches in the case of a 3 inch diameter shaft) a repair by this method is entirely feasible without injuring them, according to the Metal & Thermit Corporation, New York, if the following simple precautions are observed. There is no danger of damaging the armature windings through the effect of direct heat as the fracture is completely surrounded by molding sand and all preheating subsequent to heat from the Thermit steel is confined within this molding sand. The heat which is conducted along the shaft is readily taken care of either by directing an air blast on the shaft or, where necessary, by means of a specially constructed water cooler box with packing box on the shaft to prevent the possibility of any water whatsoever coming in contact with the windings. The windings themselves are further protected by being totally encased in an oil cloth and burlap bag.

In case the keyway of the pulley end of an armature shaft becomes badly worn, this worn end can be removed and a new over size extension welded on and machined down. A large number of such extensions have been Thermit welded in the past.

As an example of costs, in the case of an over size extension to a 3½" diameter shaft, the Thermit welding can be executed for approximately $35.00, not including machining. Smaller shafts can of course be welded for correspondingly lower costs.

APPLYING THE BRONZE FILLER

Editor:

The article published in *The Welding Engineer* of September by O. T. Hart, "Use of Bronze Filling Rod," was very interesting, although not new to me. This is a method I have used for three years.

In your issue of October I read the article by Alan H. Murrell, in which he states that cast iron should only be brazed in cases of emergencies and only temporary repairs.

Being an instructor with wide and varied experience, also having made the brazing of cast iron a specialty, I feel that I am in a position to answer Mr. Murrell.

I would not condemn the use of the gray iron filler rod, but in cases where a job requires a lot of work in preheating I recommend the bronze rod; it saves the time of preheating and can be applied much faster.

The fact that Mr. Hart brazed a crack in an air pump eighteen months ago and it is still in use ought to prove that it was not a temporary job. I know of jobs that have stood up for three years. I have had test pieces tested that showed over 100 percent, and have yet to find a piece of cast iron that cannot be brazed.

Of course, it depends upon the operator. The bronze must be carefully applied; the fracture should be V'd out the usual way; the line of weld should be coated with a thin layer of bronze before the weld is made. It is not necessary to coat the full line of the weld at one time, but it should always be kept coated two or three inches ahead. At no time should the flame be plunged into the molten metal. It is absolutely necessary that the proper flux and Tobin bronze filler rod be used.

The article in October issue of *The Welding Engineer*, by Mr. Joseph T. Paight, is a good example of what Tobin bronze, properly applied, will do. This cylinder is now in service eight months and has been proclaimed 100 percent.

Yours truly,

Fred Moritz.

The E-L Electric Welding Repair Company has recently been incorporated in the state of New York for $10,000, by M. G. and E. A. Liebman. The plant is located in Brooklyn.

The Welding Engineer

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Co-operation Within the Association

TRADE organizations are all built around the idea that "pulling together" makes for greater progress than "pulling apart." Just how far a real association spirit can be developed was brought out by a speaker at a recent society organization meeting. To illustrate the splendid spirit of co-operation which characterized another society, of which he was a member, the speaker said, "Some time ago my plant burned down. There was no way to continue production until it could be rebuilt. Did it ruin my business? Not on your life! I split up my list of customers among my competitors, giving them the average demands of each customer and the price to each customer. Every order received during the reconstruction period was filled, and every customer satisfied. When I was ready to operate again the business was turned back to me and I never lost a customer." That's "pulling together." If an association is to reach as high a standard as this the individual members must go about their work in a real, whole-hearted, broad-minded, way. The member of the American Welding Society who stays away from a meeting because the subject under discussion is steel tank welding and he is an aluminum welder exclusively, because it's election night and he doesn't care who is elected, or because he simply thinks that meeting won't be for his benefit, is both selfish and narrow-minded. Membership implies an obligation to keep the other fellow in every possible way, and to leave personal profit considerations outside.

"Safety First" with Dented Cylinders

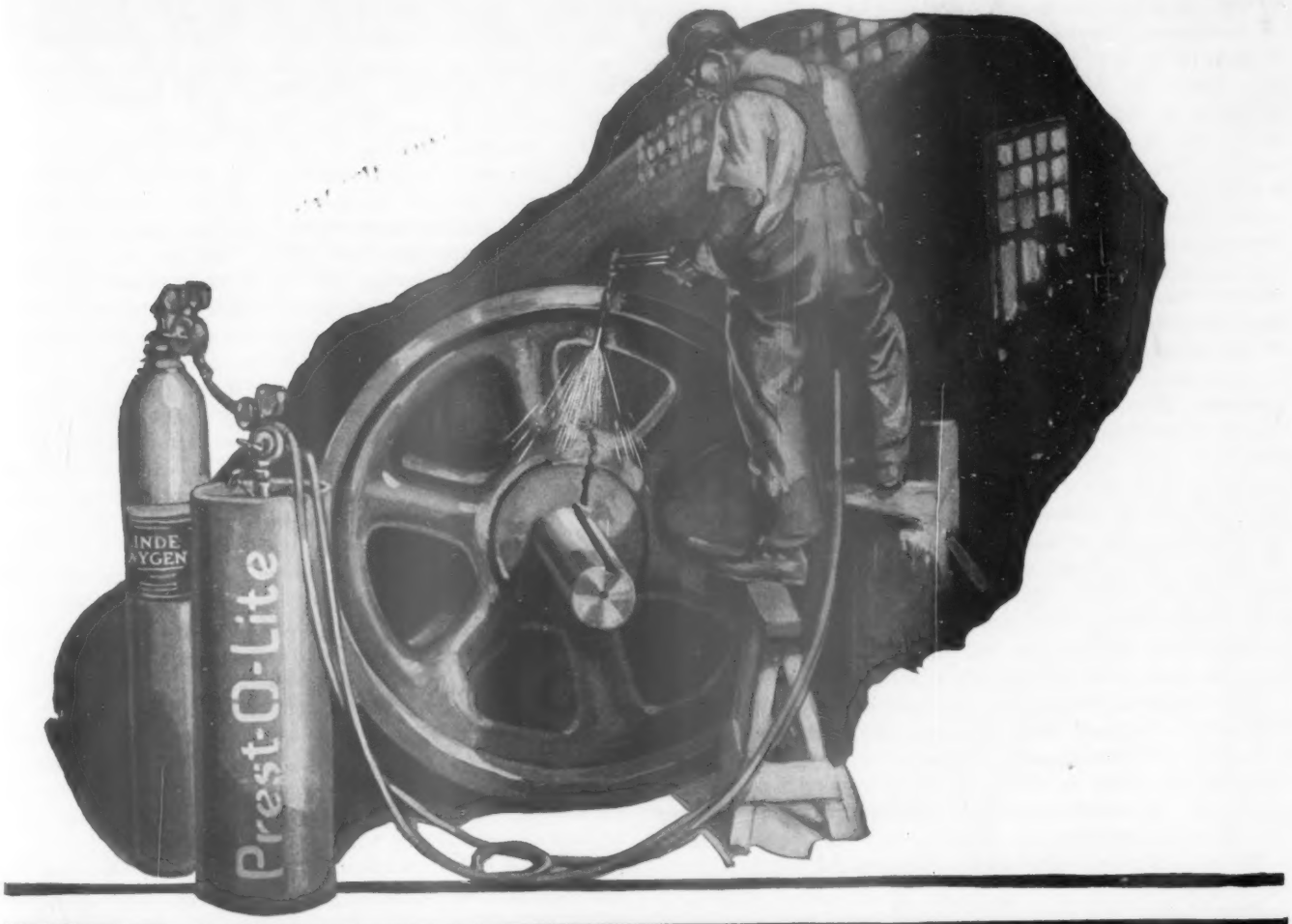
ACCORDING to a recent bulletin the Test and Specifications Committee of the Compressed Gas Manufacturers' Association has for some time been considering the drafting of rules to cover the treatment of dented gas cylinders. The bulletin goes on to quote opinions that have been submitted relative to the treatment of dented high pressure cylinders. These opinions come from gas manufacturers, gas users, and cylinder manufacturers. "It is our opinion that the safest policy to pursue would be to have the cylinders scrapped," would be a complete summary of all the discussions. The user of gases bottled under high pressure can draw his own conclusions. "Dented cylinders are dangerous," say the experts.

Much Ado About a Small Matter

EXPRESSIONS of concern are frequently heard because publicity is given to the activities of burglars with the oxy-acetylene cutting torch. The worried ones lose sight of the fact that the best cutting torch made is not nearly so good a tool for the burglar as an inefficient night watchman. Anyone familiar with the noisy and spectacular operation of cutting heavy steel sections would hesitate to try it on a safe without the co-operation of the guardians of the peace. A noted gun-man, under sentence of death, recently escaped from the Cook County jail in Chicago, after tying up his guards with Manila rope—hence the danger of manila rope to the peace and safety of our citizens!

He'll Do It Anyway

AS long as there are small boys there will be cramps in small stomachs from eating green apples. It is inevitable that they should verify the fond mother's counsel by experience. Likewise it seems almost impossible to make a certain brand of alleged mechanics understand that considerable danger attends the use of oil around valves and fittings of oxygen cylinders. Every instruction book ever written cautions users against such practice, every regulator and nearly every cylinder carries at least one warning notice, but every now and then the church bells toll for some man who "didn't believe in signs." The really regrettable thing is that sometimes a few innocent bystanders get hurt. Too much vigilance cannot be employed to keep oil absolutely away from cylinders.



A job like this is all in the day's work

THIS pulley was cut and the frozen shaft removed in perfect condition—one of hundreds of successful money saving applications of the oxy-acetylene process as used daily in machine shops the country over.

Prest-O-Lite Dissolved Acetylene has made the welding and cutting blowpipes available *anywhere* by supplying uniformly pure gas in easily portable and instantly accessible cylinders—a system of distribution so flexible as to meet every possible demand promptly and completely.

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The American Valuation Plan

THE American Valuation Association is an organization of far-sighted Americans who are devoting considerable energy to securing a much needed amendment to the pending revenue bill. Under the present system of assessing duties the foreign valuation of imported products is made the base to which the specific rate of duties is applied. The result of this plan of valuation is that merchandise from those countries whose cost of production is the lowest is subjected to the lowest duty; and the merchandise from those countries whose currency is the most depreciated is subjected to the lowest duty. Under the American Valuation plan the basis of the duty would be the American value of American merchandise, and would at all times be adequate to protect and stimulate the production and distribution of American made goods. No other adequate means of securing fair and equitable ad valorem values has been presented to Congress. The American manufacturer, the American laborer, and the American consumer will all profit by the adoption of the plan.

Get Engineers to "Think" Welding

TWELVE pages of an authoritative engineering manual are devoted to riveting and riveted joints. Not a line of the bulky, much-quoted volume refers to any welding process or to the use of welded joints. Welding is far superior to riveting for many types of work, but the engineers don't know it. They have not been made to "think" welding. The word isn't in their working dictionary. Some day twelve pages of that manual will tell the engineer about welded joints. This may be the result of experiment in university laboratories, or it may result from the co-operative effort of the engineering departments maintained by manufacturers of welding equipment. At any rate, the result will be that engineers will not accept the rivet as the one and only method of joining metal plates.

Testing Welds

TENSILE strength tests have been given so much publicity that there is danger of a tendency to judge all welds by tensile strength only. It has come to be a habit to ask "What will be the resulting tensile strength?" If this keeps up, welds on bearing surfaces will be tested on a tensile strength testing machine instead of with a sceleroscope. Metal parts have to stand vibration, bending, impact, twisting and shearing stresses, so the "tensile" test tells only a fraction of the story—an insignificant fraction in some cases. The development of satisfactory tests for determining the efficiency of welds in some other directions means a lot of hard work, but it will be good for welding.

PICKING EXPERTS

In this month's issue of the *Welding Engineer*, I thoroughly enjoyed the article of Mr. Wanamaker. This article surely was of importance to the arc welding profession: from plant engineer to the operator.

Mr. Wanamaker alludes to the scarcity of the *Welding Engineer* and predicts that his numbers will increase as the profession progresses.

As a welder, I am very much interested in the art, and especially in, what constitutes a Welding Engineer. If Mr. Wanamaker's prediction is correct, he (the Welding Engineer) is the man who, is thrown—so to speak into the melting-pot and in the course of time and the refining process rises to the top and above the lay-man of the game. This is of course a practical way of creating this new entry into the engineering field. But how are we and the welding world to know when he has reached his pinnacle.

As every employer of welders knows, the prospective employee is in too many cases a plain unadultered wind-jammer. A boilermaker friend of mine once said, after listening to a world-beater, "there must be something in that flux that makes them that way." If the title of Welding Engineer is going to be easily won, once the wind-jammer has permission or is allowed to tack W. E. behind his name, it will be a sad day for welding. If this matter is to be handled to the satisfaction of all concerned, somewhere, some time, we shall have to set standards for these men to abide by.

The American Welding Society asks that a welder have three years experience before admitting him to their class "C" (expert class.) Most of us, have known many welders who have been at the game over three years and are not yet even skilled in the few things they are able to do. Let us for example say that "A" is a welder who has worked on production work in a ship-yard. His daily life is divided into butts, blind-holes, wrongly punched holes, and a piece of caulking edge where the caulker can not get at it. Then let us consider "B" in a repair yard. He does satisfactory work on high pressure boilers. He can handle various metals, brass and bronze. He knows where and when to use the right filler. Then let us take "C." He can do all that "B" can accomplish and in addition can handle acetylene. And "D," who can handle acetylene but not the metallic arc. Surely, no two of these men are or deserve to be in the same class.

I know a ship-yard welder who was welding "dogs" and hinges for heavy iron doors. These "dogs" and hinges were about 7 inches long and 2 inches wide and about ¼-inch thick. These "dogs" were held in position by the ship-fitter and tacked by the welder at each end. After the tacking, he started to weld, commencing at the bottom and working all the way up the one side to the top. Then starting on the other side, found that it was standing off about ⅛-inch. But this did not fool this young man; showing a "dutchman" in this space he went right on welding. This man was a welder on the repairing of the German ships in '17.

When we make a survey of the papers and letters that have appeared in your magazine it seems that there are many who are of the impression that the average welder is merely interested in his rate and does not take into consideration the more important elements which go to make a failure or success of welding. This is unfair. There are many, like myself, mere welders who are behind the game all the way.

It is to the "American Welding Society" that we must look for hope. We believe, like Mr. Micawber, that "something will turn up." Mahomet said, "if the hill will not come to Mahomet, then Mahomet will go to the hill."

If those pursuing the art of welding will not stand by the American Welding Society, let the Society go to them and make it known that their standing in the profession is judged by their standing in the Society.

Very sincerely yours

L. J. C.

(Continued from page 28)

Length of Weld	Style	Bronze Lbs.	Oxygen Cu. Ft.	Acetylene Cu. Ft.	Hydrogen Cu. Ft.	Welding Hours	Labor Hours
12 ft. 7 in.	Single Seam	139	1,280	1,092	7,234	7½	18
12 ft. 7 in.	Single V....	139	1,280	1,092	7,234	7½	18

From the above results we believe that gas welding is the best method yet devised for joining heavy bronze condenser sheets, and we strongly recommend the single "V", welded according to the non-rigid system.

CORRECTION

On page 29 of the November issue of *The Welding Engineer* the formulae for volumes, given with three illustrations, do not contain the factor L. The formulae should read, from left to right:

$V=\frac{1}{2}L(A\times W)$, $V=\frac{1}{2}L(B\times W)$, $V=\frac{1}{2}L(C\times X)+\frac{1}{2}L(D\times Y)$.

The Duluth Oxygen-Hydrogen Company has been incorporated in the state of Minnesota with a capitalization of $150,000, according to reports. The plan of the company is to erect, and operate a plant in Duluth.

HEAVY MALLEABLE CASTINGS

The Cheaply Made Castings Which Find Their Way to the Welding Shop Do Not Conform to Best Specifications

By R. S. Gildart*

Nothwithstanding the steadily increasing application of malleable iron to the different branches of industry, it is not uncommon to find otherwise well informed men who still think of malleable iron as a material of only limited application and one that is confined to such light parts as harness fittings and nut crackers. Only a few days ago the writer's attention was called to an article appearing in *The Welding Engineer*, in which its author attempted to set forth some safe rules whereby one might be able to tell with ordinary accuracy a malleable casting from either cast iron or cast steel. Among other things that showed great ignorance of the real nature of modern malleable iron, this author went on to state that only as a rarity was a malleable casting ever found weighing as much as ten pounds.

Had this writer taken upon himself the trouble of verifying his statement, he would have learned that a far greater tonnage of castings weighing over ten pounds is made each year by the malleable manufacturers of this country than those under that weight. He would have learned that castings weighing forty, fifty, sixty, and one hundred pounds are not at all uncommon, and he would no doubt have been dumbfounded to have been shown a motor crank case weighing over six hundred pounds that has been successfully made of malleable for the last eight years.

It may not be known generally, but it is neverthless a fact, that many of the best automobiles made in this country have as much as 200 to 300 pounds of malleable castings in their construction; and these malleable parts are by no means subordinate ones, but play a vital part in the proper functioning of the car. Such vital parts as hubs, which must withstand the terrific side thrust of a skidding car; differential housing that form no insignificant portion of the rear axle assembly; brake spiders that must absorb the momentum of the speeding car when the emergency is applied; steering gear case which forms a trustworthy support for the steering mechanism and the steering wheel spider to which millions of drivers daily entrust their lives.

Motor truck manufacturers are also heavy users of malleable castings; thousands of tons of the product finding its way into the construction of commercial cars each year. Hubs, spring hangers, transmission housings, wheels, rear axle housings, brake spiders steering post brackets, motor crank cases are some of the parts for which malleable has been selected because of its unusual shock resisting qualities.

The railroads, too, come in for their share of the tonnage, and many and interesting are the uses to which the material is put. From the lowermost tie plate, where its peculiar rust-resisting qualities and shock-absorbing properties make it superior to any material, to the topmost freight car brake wheel, where its reliability is recognized by every brakeman who "spots" a car, malleables find many applications. There is the malleable iron journal box, millions of which are in daily use carrying the commerce of the U. S. A. over rail joints, switches, crossings and other rough going with safety to life and property. Brake heads on freight cars, passenger coaches and locomotives, and other important parts of the braking mechanism are made of malleable iron because of its trustworthiness in emergency—a less dependable material in such places would easily be the cause of many serious wrecks.

Malleable iron rail braces on curves and at switch points counteract the heavy side thrust of speeding locomotives and prevent spreading of rail and derailment.

The taking of water by locomotives at full speed is accomplished with safety because the water scoop dipper which the fireman lowers into the track pan is made of high quality malleable iron.

Piles for building foundations or dock construction are successfully driven through hard pan, shale and loose rock only when their points are properly protected. Pile shoes of the inverted pyramid type made of high quality malleable iron make penetration easy under the crushing blows of the pile driver.

Street railway companies have found that cross arms of malleable iron successfully withstand the clamping strains incident to construction work and the service loads of heavy copper cables with their snow and ice loads and terrific wind stresses that come with yearly regularity.

The wonderful conveyor systems with their endless chains of malleable links have made possible the economical handling of raw and semi-finished materials of every description through all the steps of production from mine or mill to the completed product. Here the great strength and high elastic limit of the metal are exceptionally valuable in producing a smooth running chain comparatively free from the interruptions to service that are caused by alterations of original pitch or breakage.

A large tonnage of malleable is used by manufacturers of farm implements and tractors. The development of power farming has shown the necessity for implements of greater strength and reliability. The positive pull of the farm tractor must be met by greater strength in implement parts. Parts that were heretofore of sufficient strength to stop a team of horses when the implement met with an obstruction, could not longer stand up under the greater pulling effort of the tractor. Here also the well known rust resisting quality of malleable iron is another point in its favor. Though of necessarily heavier cross section than many parts of pressed steel, its greater ability to withstand the action of the elements gives to it a much longer life.

The sudden impact of parts incident to the operation of printing presses and baling presses makes necessary the use of malleable iron if breakage and loss of time is to be prevented.

Evidently your correspondent is not familiar with these manifold applications of malleable iron. His lack of information is further indicated by his conception of the real nature of the material. He describes and pictures a malleable casting as having a "steel veneer and a cast iron center." Twenty years ago much of the malleable produced did have something of these characteristics, but the improvement of malleable has not remained stationary while that of other materials has gone ahead, by any means. If there is any malleable that has the characteristics he pictures, it is very poor material and not representative of that which is being made today by the more progressive foundries.

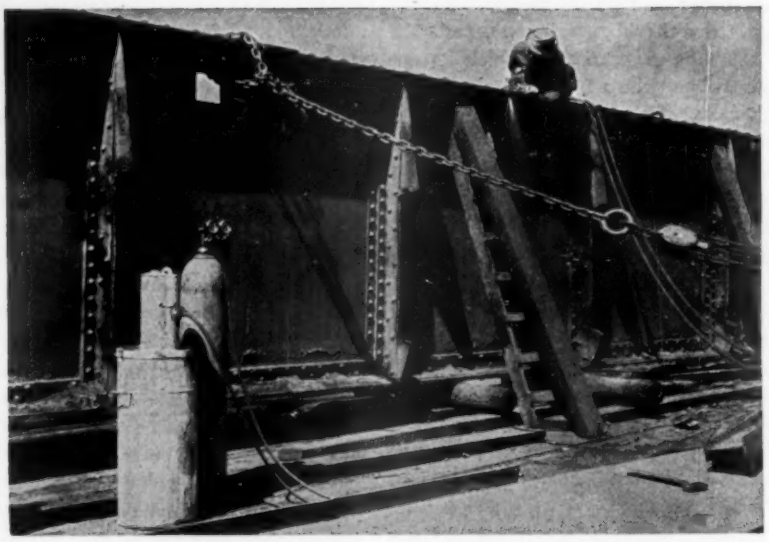
This conception of a so-called "outer skin" and a brittle and worthless interior is nothing new, but has for its foundation the exploded theory that the materials in which the castings are packed for the annealing process is the principal agency producing malleability. This we now know is not true. Indeed it is possible to anneal castings without any packing material whatever.

The annealing process is really a heat treatment that affects

*Director of Publicity, American Malleable Castings Association.

Carbic

After 16 Minutes—



Ready for the Next Job

Sixteen minutes from the time this picture was taken the operator had cut through this ½ inch girder, 7 feet, 3 inches high with 2 x 14 inch flanges top and bottom, and was ready to move on to the next job.

That's one of the advantages of the Carbic System—Acetylene generation from cakes of Carbic—it does its job quickly and then you can **pick it up** and move on. Because the Carbic generator completely charged weighs only 200 lbs.

Besides being portable, the Carbic System is safe; your gas supply is always assured; and acetylene from Carbic costs but half as much as compressed acetylene.

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all parts of the casting from surface to center; the only requirement for a complete transformation being that the casting be heated throughout its mass up to a certain "critical" temperature, maintained at that temperature for a certain period, and then gradually cooled down to a point where the casting can be handled. The complete transformation requires a period of seven or eight days. True, some carbon is eliminated through use of an active packing material, but not to an extent that accounts for the great strength of the material.

Not only does micrography show the structure of a properly annealed malleable casting to be consistent throughout its mass, but this has been reepatedly proved by physical test. Test bars of twice the diameter of the standard bar have been turned down until this so-called "skin" has been completely removed and then tested for tensile strength and elongation. The results so closely coincide with those for an unmachined bar from the same heat and anneal, as to leave no chance for argument. Simple computation will show that this thin "skin" could not possibly account for the great strength of properly made malleable.

Automobile companies, the largest users of malleable, certainly do not place any credence in such a theory, for practically all of their castings are machined, and why should they machine away the part to which is attributed all the strength and leave only the weaker portions? The real facts are that properly made malleable castings, such as are made in conformity to the best engineering requirements, are just as strong and trustworthy at the center as at the surface.

It is of course incumbent upon the user of malleable iron to take every possible precaution to insure himself that he is obtaining malleable castings of uniformity and integrity, otherwise his selection may endanger lives and property, for malleable iron like every other commodity, is not always of superior grade.

Although more uniformity exists in the plant practices of malleable manufacturers now than a few years ago, there is still a considerable tonnage made each year that is lacking in the essential properties of strength and ductility on which the quality of high grade malleable depends. But how is the buyer to know when he is getting a reliable product and one that fulfills the required specifications? It is quite impossible for him to examine the interior of every casting, and he cannot depend entirely upon the assurance of the manufacturer that the castings are what they should be, for the manufacturer is naturally prejudiced in favor of his own product.

Some time ago The American Malleable Castings Association inaugurated a plan of issuing quarterly certificates to those plants whose product as shown by test bars submitted daily to the Association's consulting engineer, and whose castings and plant practice as reported by Association inspectors were in conformity to its requirements. As a guide to the purchaser of malleable castings, the Association publishes the names of its certificate holders and designate the product of such plants as "certified" malleable castings. These lists are available to any purchaser of malleable and offer a dependable safeguard to the securing of castings of positive physical properties. Thus the element of chance is eliminated for the purchaser, and the reputation of the trustworthy malleable casting is protected.

WELDING IS MALLEABLE CASTINGS*

Welding of broken or defective castings by the user is of course subject to the limitations which apply to this operation when carried on by the producer with the additional difficulty that reannealing is impracticable. Had the consumer facilities for the long and accurately controlled heat treatments required, he could of course weld in the same manner as does the malleable founder. During annealing finished surfaces would suffer and warping might possibly occur. Under ordinary conditions, therefore, welding with iron is not to be regarded as practicable as a repair operation. Thus no repair can be made, irrespective of the welder's skill, which will restore the original strength of the casting.

The only resource is to braze, that is, to use bronze as the welding material. The melting point of bronze is low enough to permit operating below the critical point for iron hence if care is used a weld can be made without heating the metal to a dangerous degree. This, however, involves great skill and care on the part of the welder. Ordinary brass, Tobin bronze and Parsons' manganese bronze have been suggested as suitable for this work. Welds made with nonferrous metals of course, do not permit of the complete merging into one another of the metal used as filler with the material being repaired.

They apparently fail invariably by tearing apart between the iron and bronze, thus developing the entire strength of neither material. The strongest welds of this type ever tested by the writer were made by an expert operator using Parsons' bronze. These welds developed an adhesion between iron and bronze of substantially 45,000 pounds per square inch thus producing a tensile strength of the welded part approximately equal to the American Society for Testing Materials, specifications for malleable iron.

The failure occurring entirely along the plane of contact between bronze and iron produced a failure with only a negligible elongation, as might be expected. If the circumstances are such as to permit making a joint similar in form to the wiped lead joint of the plumber, running the bronze up on the side of the iron part some distance each way, welds occasionally can be made with this metal which develop the full strength of the original metal, elongation excepted. Such welds are seldom made.

Work of this character can be intrusted only to very skillful artisans. Unusual care and ability are required to produce mechanically perfect welds without even momentary overheating of the surrounding metal. Theoretically, there should be no reason for preferring electric to acetylene welding or vice versa, but the writer's observation has been that better work is obtained with the gas torch. Possibly this observation may be due to the relative skill of the operators whose work has been observed.

By H. A. Schwartz, Metallurgical Engineer, The National Malleable Castings Co.

(Note:—The above article was published to dispel any idea which may have been formed to the effect that the welding industry wishes to condemn any metal. "Malleable castings that are made in strict conformity to Association standards," says Mr. R. S. Gildart, of the American Malleable Castings Association, "seldom require welding, as their nature is such that they are considerably deformed before rupture occurs. Ordinarily it is the poor malleable casting, or one that does not conform to specifications, that fractures and requires welding"—and it is the malleable casting requiring welding which the welder meets most often.

Regarding the welding of malleable castings, Mr. Gildart says, "It is always necessary after welding a malleable casting to reanneal it, as the heat required for welding causes the iron to revert to its original hard iron condition. The material used for welding a malleable casting that is to be re-annealed should be the same metal as that of which the casting is composed. When castings cannot be annealed, brazing is considered the best practice, but in no case should the casting be heated to a temperature closely approaching the critical temperature. I believe the recommended temperature is not over 900 degrees."—Editor.)

Three and one-half acres of ground have been purchased by the Youngstown Welding Company, Youngstown, Ohio, on which the company expects to build a new plant during the early part of next year. The new plant will comprise three buildings each 100x298 feet.

The Detroit Boiler & Welding Co., 2024 E. Atwater Street, Detroit, is specializing in boiler repairs and small tank work. It has a portable welding plant installed on a truck.

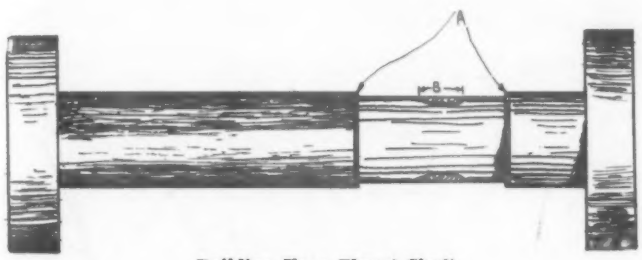
Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

BUILDING UP A THRUST SHAFT

Editor:

Here is a rough sketch of a thrust shaft of a tugboat, which has recently been repaired, and you might say remodeled, at the yards of the Staten Island Shipbuilding Company. At points "A" the metal was badly worn, and new metal one-half inch wide and 5/16 inch thick was built up around the shaft at this point. This was turned down in a lathe flush with the main part of the shaft. At point "B" new metal 2¼ inches wide and 11/16 inch deep was built up around the shaft, and then turned down in a lathe to 2x½ inches. The shaft at its smallest section was seven inches in diameter, and the welding



Building Up a Thrust Shaft.

required about eight hours. No effort was made to break any records because the welders had just finished a twenty-four-hour continuous weld on a similar job on the S. S. Kentuckian and were just able to keep awake. A 60V. 125A current was used and a 5/32-inch flux-coated electrode. It is remarkable how easily and economically these shafts can be rebuilt. There is no preheating or reheating and no trouble with warping. We have many jobs of this sort, where we merely rebuild worn spots. On the S. S. Kentuckian 1430 sq. in 5/16 inch thick were welded. The welders averaged 14 sq. in. per hour per man. The job on the thrust shaft is a lesson in the possibilities of the use of the electric arc for rebuilding worn machinery.

L. J. CULLEN.

OXY-ACETYLENE CUTTING IN REINFORCED CONCRETE CONSTRUCTION

By B. Heyman

In almost all industries there have been found numerous applications for the oxy-acetylene processes—welding, cutting, and brazing. In manufacturing, where production in large quantities at low unit cost is of prime importance, the use of the welding torch does not now create any unusual interest, as it did only a few years ago. Repair work, involving operations on fractured parts, invariably brings into play the so-called welding engineer to the utmost satisfaction of all parties concerned. And the same may be said of the cutting process in steel mills, scrap yards, etc.

But every little while there crops up some new application of the process which may not have been considered previously and which may be utilized to great advantage by others interested in the same or similar types of work. One of the most important branches of the building game—reinforced concrete construction—has found ready use for both welding and cutting torches, and it is my intention to describe briefly an interesting piece of work which resulted in a great saving of time and money to those engaged in constructing an immense reinforced concrete building.

The building referred to is located at Twenty-fourth and Market Streets, Philadelphia, Pa., and known as the Hudson Motors Co. Originally the plans for the structure called for eight floors, which number was later changed to four. The steel had been set for the fourth floor and all columns were in place preparatory to pouring concrete, when an order was issued changing the number of floors to five. Ordinarily this necessitated removing the columns and cutting off lengths varying from 4 to 6 feet of 1¼-inch wrought iron, which, had the original procedure been followed, would have been bent over and imbedded in the concrete in the roof. The cutting of these rods was necessary for proper splicing of another set of columns around which the fifth floor would be formed.

Dismantling a column, cutting to length, and reassembling was an operation requiring the use of at least two men for several hours. And there were a very large number of these columns to be changed.

The writer was called into consultation regarding the matter, and suggested the use of the cutting torch, without dismantling the columns. The suggestion was accepted, and in less than a day the rods had been shortened without any interference to preparations for pouring the concrete, and the use of only one man for the entire work.

The speed with which these rods had been severed attracted the attention of the steel men, who had on hand several thousand 1¼-inch rods of various lengths which would be required for making up the fifth floor columns. Previously these rods had been cut with a small hand shear—a very laborious piece of work. Two men were required to handle an eight-foot pipe on the handle of the machine, while another guided the rod. But no headway was being made.

Simply as a trial, 50 pieces were placed side by side on the ground and close to each other. At one end a straight edge was placed and all 50 trued up at that end. A chalk mark was then drawn across all 50 at the point where they were to be cut. It took about 4½ minutes to cut all 50 with an almost inappreciable gas consumption. Needless to relate, the remainder of the rods were cut in the same manner, and the writer has handled much similar work for these people at their storehouses, since that time.

During the last day of the writer's stay at this building, carelessness on the part of the riggers caused the fall of one of the derricks. The cutting blow-pipe was used advantageously in clearing away the wrecked parts and cutting to shape such parts as could again be used. A special nozzle was used for cutting off rivet heads, so that the shanks could be drifted out with a sledge hammer.

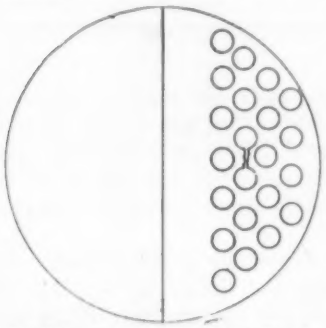
When the fifth floor had been poured special steel shapes were placed in position for holding the elevator operating mechanism.

These girders were inserted into the spirals forming the columns at that point and the spirals tacked to the web of the girder. Incidentally the cutting torch was used to cut the holes for anchoring bars, thus saving the time and trouble which would have resulted in the use of an electric drill.

CRACKED FLUE SHEET

By P. C. Utley

This little sketch will illustrate the repair of a cracked flue sheet which we finished recently. The plan we used saved preheating the sheet and served the purpose in every way. The sheet was never too warm to hold your hand on it three inches away from the weld. This is the first time we have ever been able to fix a crack in this sort of a place without having trouble with cracking, unless the job was preheated.



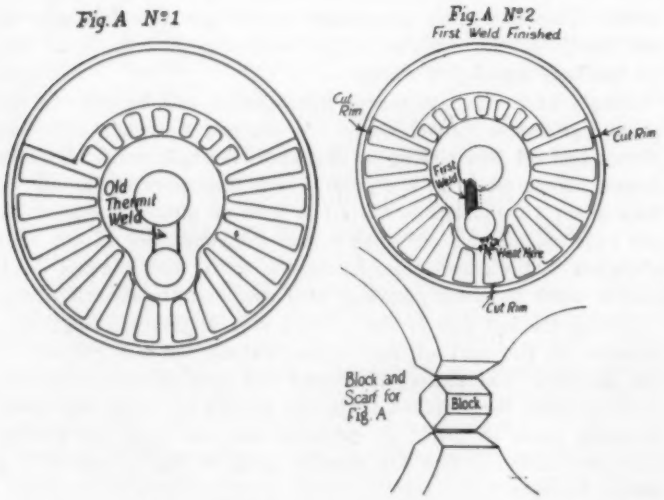
Position of Crack in Flue Sheet.

The work was done with the flue sheet in place in the boiler, making it a vertical weld. We first beveled out the crack and cleaned it well, using a large torch and working fast, barely getting the steel to a brazing heat, and not holding it at this heat over a minute or two. We applied as much Tobin Bronze as we could in that length of time, and allowed it to get cool, repeating the operation until we had filled up the crack. This kept expansion down to practically nothing. This work was done for a mining company on September 19, with the flue sheet in place in the boiler. The main object was to save the time required to replace it. It would have been practically impossible to preheat this job and stay close enough to it to work on it, as it was in the rear sheet and a close place to work. This boiler is in service twenty-four hours a day, seven days per week, with the exception of about eight hours every ten days, when the steam is blown from it, it is cooled, inspected and cleaned out. It has had this service since September 20th, and at the last inspection, a very few days ago, it was apparently as good as new.

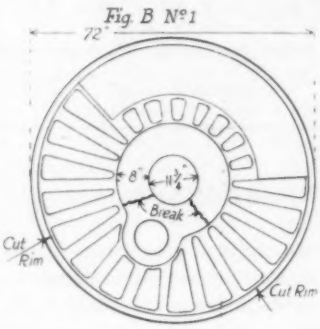
WELDING STEEL DRIVING WHEELS

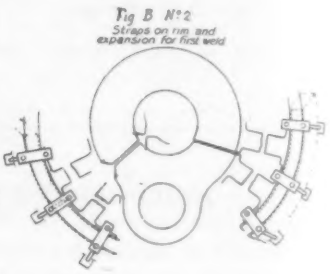
By George Hanskins

Figure A shows a driving wheel that was broken from the crankpin hole through the hub, and was welded with thermit on two different occasions, and failed.

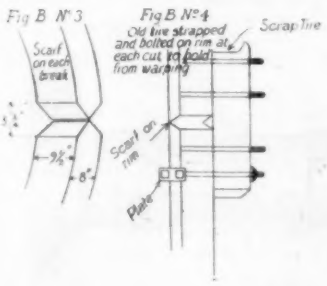


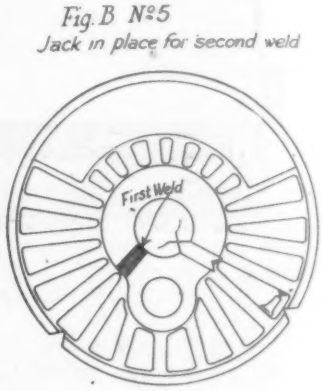
In preparing this wheel for welding it was necessary to cut an opening of nine inches to rid the weld of the old thermit. This being all together too large a place to fill with the filler rod a block was made and scarfed to about a 45 degree on both sides and the hub of the wheel was scarfed to match, as shown in sketch. In placing this block in the opening it makes two welds, one on each side of the block. Both block and wheel hub were scarfed half way on each side, so that half of the weld was made from opposite sides. Standing the wheel in an upright





position an operator was started on the two sides of the weld at the same time, and the first weld was made without paying any attention to expansion, as the block was free to contract,





being loose on one side. After the first weld was made, the rim of the wheel was cut in three places, the center place being over the crankpin hole, leaving the wheel in an upright position, so that an operator could work on each side. Then we heated the opposite side of the crankpin hole, directly across from the remaining weld (as shown in Figure A, No. 2). Sufficient expansion can be gotten in this manner to allow for shrinkage on the second weld, keeping the heated part hot while making the weld. It is not necessary to weld the openings in the rim, as they can be keyed.

In welding a wheel with a clean break proceed the same as in making the second weld.

Figure B shows the same type of wheel broken in two places in the hub between the spokes. In preparing these welds, they were scarfed half way on each side, so that an operator could work on each side at the same time, or in the same manner that the welds were prepared in Figure A. The hub was trammed on both welds, so that the amount of expansion could be determined, being careful to put good punch marks well out from the weld, so that they will not be destroyed when the weld is being made. After the weld is made you can determine the amount of shrinkage in the weld. After the welds have been scarfed and trammed, cut the rim in two places, directly over the break in the hub, and between the same two spokes. This leaves the wheel in two pieces. Then take two pieces of old tire about five feet long and clamp to the rim over each cut. It is well to clamp these pieces in place before cutting the rim.

They will then hold the two pieces in place. Then secure the expansion for the first weld (these details are shown in Figure B, No. 2). A full quarter inch should be allowed for shrinkage, and be sure that the clamps are tight, so that the pieces will hold in place. Bolts and strap irons are preferable for clamps, standing the wheel in an upright position, so that both sides of the weld is in a position to be worked on at the same time, and being careful to keep the two sides of the weld coming out together, so that there will not be any side pull on the weld. After the first weld is made allow the wheel to cool, then loosen the bolts or clamps slightly and place a jack between the spokes over the remaining weld, and jack open the break for expansion a full quarter inch (as shown in Figure B, No. 5). Then proceed with the second weld in the same manner as the first weld was made, allowing the wheel to cool again and welding the rim at the two points cut. By welding the rim where it was cut it will strengthen the welds and support them when the wheel is pressed on the axle.

I mentioned scrap tire because it is about the same radius as the wheel rim can be readily clamped in place. A good grade of steel filler rod should be used on these wheels, as a high tensile strength is needed to stand a press fit.

CRACKED HAMMER COLUMN

Editor:

This big Chambersburg hammer was welded over a year ago, when I was doing electric welding in Detroit and vicinity. The crack was 38 inches long, and the metal was broken right through to the chamber of the hammer. It was necessary to chip

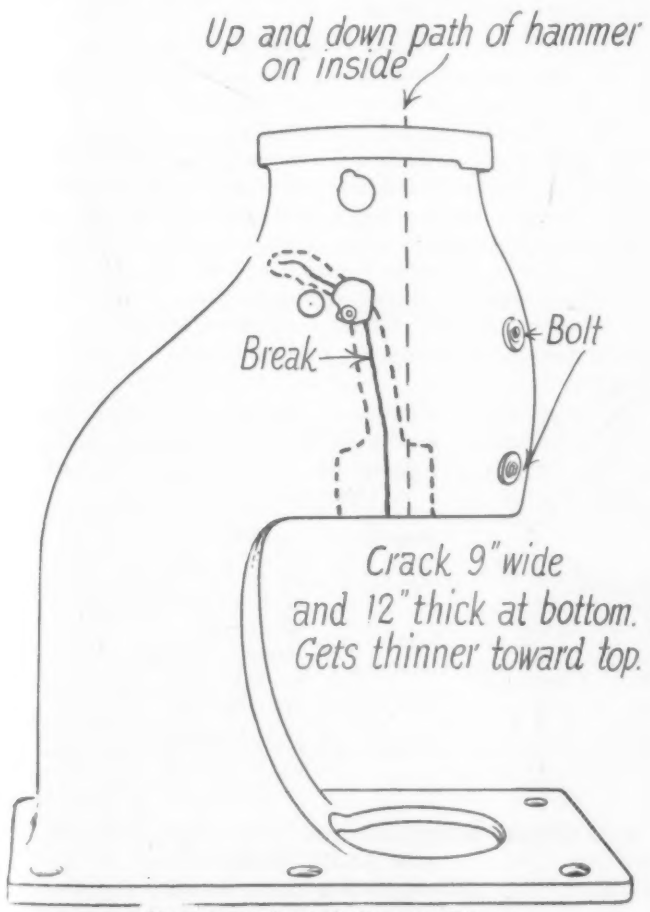


Diagram of Cracked Hammer Column.

it nine inches wide in order to drill holes for studs. After this was beveled out, ¾-inch studs were put in, two inches apart, and cut off ½-inch from the casting. Then I took ⅛-inch wire and covered the sides, also the studs. The reason for using this small wire on so large a job is because I have always had better results working on cast iron with the smaller wire. After I had it all covered I took ¼-inch rods and finished the job. Of course I had steel to work on after the cast iron was all covered.

Crack in Steam Hammer Before Welding.

The photographs show the job before it was touched and after the job was completed, and the sketch gives a good idea of the

The Finished Weld.

dimensions. The casting is thinner at the top than at the bottom.

J. Palmer.

PROCEEDINGS *of the* AMERICAN WELDING SOCIETY

33 West 39th Street, New York

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AMERICAN WELDING SOCIETY
1921-1922

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Herman Lemp, Chairman, Revision of Constitution and By-Laws Committee.

WELDING WIRE SPECIFICATIONS

TO THE WELDING INDUSTRY

We are submitting herewith specifications for Welding Wire. Several years ago the notion prevailed that almost any fence wire was good enough for welding and although good results were sometimes obtained from the use of fence wire, it is now recognized that most careful attention must be given to the physical as well as to the chemical characteristics of welding wire if good results are to be assured.

During the greater part of the past year and a half the Welding Wire Specifications Committee has been actively engaged in collecting data as to the chemical analysis of welding wire used for both gas and electric welding in railroads, shipyards and other places and the service results obtained from the use of such wire. The specifications and information given below is based upon this information and the experience of experts.

C. A. ADAMS,
Director, American Bureau of Welding.

Report to the American Bureau of Welding of the Committee on Welding Wire Specifications

We are submitting herewith Specifications and Folios on Welding Wire to be used for various purposes as follows:

SPECIFICATIONS

I. Bare Iron and Steel Electrodes

(a) For welding mild steel, structural shapes, plates, bars, or low carbon steel forgings and castings.

(b) For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch points, bearing surfaces, etc.

II. Iron and Steel Gas Welding Rods

(a) For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

FOLIOS

I. Coated or Covered Electrodes

(a) For building up worn surfaces that require machine finish such as wheel flanges, axle collars, etc.

(b) For use on high carbon steels and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary such as—rails, frogs, switch points, bearing surfaces, etc.

(c) For use on manganese crossing centers, frogs, switch points, dredging buckets, and other parts where an extremely hard tough surface is required.

II. Steel and Non-Ferrous Gas Welding Rods

(a) For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as—rails, frogs, switch points, bearing surfaces, etc.

(b) Welding mild steel to obtain greater strength but lower ductility than standard specifications.

(c) For general welding of cast iron parts.

(d) For brazing.

(e) For welding malleable iron, bronze and brass where high tensile strength is required.

(f) For general welding of copper sheets and rods.

(g) For general welding of aluminum.

The distinction between the specifications and folios are that the specifications are definite recommendations of the Committee, which in accordance with the ruling of the Bureau are to be valid for the period of one year, while the folios contain information which the committee offers solely as a guide for the selection of welding material of the nature described. The information in the folios must not be considered as direct recommendations as investigations have not been completed at this time, which would permit the preparation of specifications for this class of material.

The Committee will continue in its search for further information and whenever definite results are obtained as to any particular electrode or welding rod, we will submit the same with recommendations as to its adoption.

Respectfully submitted

D. C. Alexander	H. L. Whittemore
A. S. Kinsey	J. Churchward
J. F. Lincoln	H. J. Horn
O. H. Eschholz	Hermann Lemp
E. J. Wanamaker	S. W. Miller
W. J. Beck	H. I. Walsh
H. G. Knox	J. J. Flaherty
C. J. Nyquist	C. J. Holslag
J. W. Owens	C. A. McCune, Chairman

AMERICAN WELDING SOCIETY SPECIFICATIONS FOR ELECTRODES IRON AND STEEL BARE

Issued April 1, 1920
Revised May 1, 1921

General:

1. The following specifications prefixed by the letter E are recommended for the purchase of all bare iron and steel electrodes for use in arc welding. The use of each particular type of electrode is specified below.

Scope:

2. The electrodes herein specified are recommended as covering the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies, such as the American Bureau of Shipping, The Interstate Commerce Commission, etc.

Material:

3. Material made by the puddling process is not permitted.

Physical Properties:

4. Electrodes shall be made of commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipe, seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Nomenclature:

5. The prefix letter E is to indicate that the material is intended for electric arc welding.

Chemical Composition:

6. The chemical composition of electrodes shall be within the following limits for uses specified:

Low Carbon Iron or Steel
E-No. 1A

Carbon	not over 0.06 of one per cent
Manganese	not over 0.15 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.08 of one per cent

E-No. 1B

Carbon	0.13—0.18 of one per cent
Manganese	0.40—0.60 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.06 of one per cent

The difference between E-No. 1A and E-No. 1B electrodes is one of chemical composition incident to manufacture only. In order to assure uniformity of product close limits are demanded. Either E-No. 1A or E-No. 1B may be supplied unless the purchaser, in ordering, specifically excludes either.

Medium Carbon Steel

The data at hand shows that Bare Steel Electrodes having a carbon content of .18 to .85 are of no particular value.

High Carbon Steel
E-No. 1C

Carbon	0.85—1.10 per cent
Manganese	0.30—0.60 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent

Recommended Sizes:

7. E-No. 1A and E-No. 1B.....1/16, 3/32, 1/8, 5/32, 3/16, 1/4 inch dia.
E-No. 1C .....1/8, 5/32, 3/16, 7/32, 1/4, 5/32, 3/8 inch dia.

Uses:

8. E-No. 1A and E-No. 1B—For welding mild steel, structural shapes, plates, bars or low carbon steel forging and castings.

E-No. 1C—For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch points, bearing surfaces, etc.

Surface Finish:

9. The surface shall be smooth and free from rust, oil or grease.

Tests:

10. In the hands of an experienced welder electrodes shall demonstrate good weldability in "flat" and "overhead" positions and shall pass through the arc smoothly and evenly without any unusual characteristics.

Packing:

11. Electrodes shall be delivered in coils or in straight 14 inch lengths, packed and wrapped as follows:

(a) ***Bundles*** of 50 lb. net weight, securely wired and wrapped in heavy weatherproof paper.

(b) ***Bundles*** of 50 lb. net weight, securely wrapped in heavy burlap.

(c) Boxes or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (a).

(d) Boxes or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (b).

(e) Coils of approximately 50 or 100 lb. net weight, and wrapped as per paragraph (a) or (b).

Marking:

12. All bundles, coils, boxes or kegs shall be provided with a metal, linen or strong fibre tag securely wired to or in the case of boxes or kegs, mailed on the outside, bearing the following information:

Make .....
Specif. No. .....
Dia. .....
Nom. Weight .....

Ordering:

13. Material ordered under these specifications shall be known as:

"Electrodes, iron and steel, bare," American Welding Society Specifications Number 1, Revised May 1, 1921.

All orders should be specified in pounds. In addition, requisitions shall show the following:

Specif. No.
Size
Packing

As a guide in ordering, the following information is of use:

Size, inches	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16
Lb. per 100 ft	1.04	2.3	4.1	6.5	9.3	12.76	16.7	21.0	26.0
Ft. per 100 lb	9615	4273	2403	1537	1067	700	600	473	383
Mils	63	94	125	156	188	218	250	281	312

AMERICAN WELDING SOCIETY SPECIFICATIONS FOR GAS WELDING RODS, IRON AND STEEL

Issued April 1, 1920
Revised May 1, 1921

General:

1. The following specifications, prefixed by the letter G, are recommended for the purchase of all iron and steel welding rods for use in gas welding. The uses are specified below.

Scope:

2. The welding rods herein specified are recommended as covering the usual railroad, shipyard, and industrial requirements as are allowed by authoritative regulating bodies, such as the American Bureau of Shipping, the Interstate Commerce Commission, etc.

Material:

3. Material made by the puddling process is not permitted.

Physical Properties:

4. Welding rods shall be made of annealed commercially straight wire of uniform homogenous structure, free from irregularities in surface hardness, segregation, oxides, pipe, seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Nomenclature:

5. The use of the prefix letter G is to indicate that the material is intended for gas welding.

Chemical Composition:

6. The chemical composition of the Welding Rods shall be within the following limits:

G-No. 1A

Carbon	not over 0.06 of one per cent
Manganese	not over 0.15 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.08 of one per cent

Recommended Sizes:

7. .....1/16 3/32 1/8 5/32 3/16 1/4 5/16 3/8 inch diameters.

Uses:

8. For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

Surface Finish:

9. The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper coated.

Tests:

10. In the hands of an experienced welder welding rods shall demonstrate good weldability and shall flow smoothly and evenly without any unusual characteritsics.

Packing:

11. Welding Rods shall be delivered in coils or in straight 36 inch lengths, packed and wrapped as follows:

(a) *Bundles* of 50 lb. net weight, securely wired and wrapped in heavy weatherproof paper.

(b) *Bundles* of 50 lb. net weight, securely wrapped in heavy burlap.

(c) *Boxes* or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (a).

(d) *Boxes* or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (b).

(e) *Coils* of approximately 50 or 100 lb. net weight and wrapped as per paragraph (a) or (b).

Marking:

12. All bundles, coils, boxes or kegs shall be provided with a metal, linen or strong fibre tag securely wired to or in the case of boxes or kegs nailed on the outside, bearing the following information:

Make .....
Specif. No. .....
Dia. .....
Nom. Weight .....

Ordering:

13. Material ordered under these specifications shall be known as:

"Gas Welding Rods," American Welding Society Specifications No. 1, revised May 1, 1921.

All orders should be specified in pounds.

In addition, requisitions shall show the following:

Specif. No.
Size
Packing

As a guide in ordering, the following information is of use:

Size, inches	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Lb. per 100 ft.	1.04	2.3	4.1	6.5	9.3	16.7	26	37.5
Ft. per 100 lb.	9615	4273	2403	1537	1067	600	383	266
Mils	63	94	125	156	188	250	312	375

AMERICAN WELDING SOCIETY COATED ELECTRODE FOLIO NO. 1-E

Issued May 1, 1921—Chemical Analysis of Coated or Covered Electrodes

General:

Coated and covered electrodes have a distinct field in arc welding, but the Welding Wire Specification Committee is not prepared to recommend any chemical analyses of material, forms of coating or covering.

The data contained herein is the result of investigation by the committee to date and is offered solely as a guide for the selection of welding material of the nature described.

This folio must not be considered a direct recommendation as investigations have not been completed at this time which would permit the preparation of specifications for this class of material.

Coated and covered electrodes afford a broad field for research and specifications will be prepared for such electrodes as determined.

Sizes:

1/8, 5/32, 3/16, 1/4, 5/32 and 3/8 inch diameters.

Chemical Composition:

The chemical composition shall be within the following limits for the uses specified:

Low Carbon Iron or Steel

No. 1

Carbon	not over 0.06 of one per cent
Manganese	not over 0.15 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.08 of one per cent

No. 2

Carbon	0.13—0.18 of one per cent
Manganese	0.40—0.60 of one per cent
Phosphorus	not over 0.04 of one per cent
Sulphur	not over 0.04 of one per cent
Silicon	not over 0.06 of-one per cent

Uses:

For welding mild steel, structural shapes, plates, bars or low carbon steel forgings and castings.

Medium Carbon Steel

Carbon	0.25—0.35 of one per cent
Manganese	0.30—0.60 of one per cent
Phosphorus	(under) 0.04 of one per cent
Sulphur	(under) 0.04 of one per cent
Silicon	(under) 0.12 of one per cent

Uses:

Building up worn surfaces that require machine finish, such as Wheel Flanges, Axle Collars, Etc.

High Carbon Steel

No. 1

Carbon	0.60—0.75
Manganese	0.60—0.90
Phosphorus	not over 0.04
Sulphur	not over 0.04

No. 2

Carbon	0.85—1.10
Manganese	0.30—0.60
Phosphorus	not over 0.04
Sulphur	not over 0.04

Uses:

For use on high carbon steels and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as rails, frogs, switch point, bearing surfaces, etc.

Manganese Steel

Carbon	1.10 — 1.35 per cent
Manganese	11.00 —14.00 per cent
Phosphorus	.017— .04 of one per cent
Sulphur	.007— .04 of one per cent
Silicon	.10 — .20 of one per cent

Uses:

Manganese Crossing Centers, frogs, switch points, dredge buckets, and other parts where an extremely hard tough surface is required.

Cast Iron

There is not sufficient data on an electrode of cast iron analysis. Therefore, the chemical composition as given for low carbon iron and steel will govern for the present.

Uses:

Cast Iron parts studded or general welding.

Notes:

All non-ferrous electrodes are being investigated and folio will be issued when sufficient data has been secured.

AMERICAN WELDING SOCIETY FOLIO NO. 1-G

Chemical Analysis of Gas Welding Rods for Welding High Carbon Steels, Non-Ferrous Metals and Mild Steel (Greater Strength but Lower Ductility Than G No. 1A)

Issued May 1, 1921

General:

The data contained herein is the result of investigation by the committee to date and is offered solely as a guide for the selection of welding material of the nature described.

This folio must not be considered a direct recommendation as investigations have not been completed at this time which would permit the preparation of specifications for this class of material.

This is a very broad field for research and plans are being developed whereby each class of material will be definitely recommended as determined.

Nomenclature:

In referring to folio, the analysis prefixed by the letter G indicates the material is intended for gas welding.

Chemical Composition:

The chemical composition shall be within the following limits for the uses specified:

Medium Carbon Steel

The data at hand shows that welding rods having a carbon content ranging from .06 to .60 are of no particular value.

High Carbon Steel

Carbon	0.60—0.75	of one per cent
Manganese	0.60—0.90	of one per cent
Phosphorus	not over 0.04	of one per cent
Sulphur	not over 0.04	of one per cent

Physical Properties:

Rods shall be made of annealed commercially straight wire of uniform homogeneous structure, free from irregularities in surface hardness, segregation, oxides, pipe, seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Surface Finish:

The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper coated.

Recommended Sizes:

⅛, 5/32, ¼ inch diameters.

Uses:

For welding high carbon steel and worn surfaces where great resistance to abrasive wear is desired and where machining is not necessary, such as—rails, frogs, switch points, bearing surfaces, etc.

Nickel Steel

Nickel	3.25—3.75	per cent
Carbon	0.15—0.25	of one per cent
Manganese	0.50—0.80	of one per cent
Phosphorus	not over 0.04	of one per cent
Sulphur	not over 0.04	of one per cent

Physical Properties:

Rods shall be made of annealed commercially straight wire of uniform homogenous structure, free from irregularities in surface hardness, segregation, oxides, pipe seams, etc. Diameter shall not vary more than plus or minus 3 per cent from diameter specified.

Surface Finish:

The surface shall be smooth and free from scale, rust, oil or grease, and may be plain or copper coated.

Recommended Sizes:

⅛, 5/32, ¼, 5/16, ⅜ inch diameters.

Uses:

For welding mild steel, producing, however, a weld of greater strength but a lower ductility than secured with G-No. 1A in standard welding rod specifications.

Cast Iron

Carbon	3.00—3.50	per cent
Manganese	0.50—0.75	of one per cent
Phosphorus	0.50—0.70	of one per cent
Sulphur	0.10	of one per cent
Silicon	3.00—3.50	per cent

Physical Properties:

Rods shall be commercially straight, of either round, hexagonal or other regular shape.

Surface Finish:

The surface shall be cleaned and free from sand, dirt or scale.

Recommended Sizes:

5/32, ¼, ⅜ and ½, and in 12 to 18 inch lengths.

Uses:

For general welding of cast iron parts.

Tests:

Rods when broken shall show a uniform grain of gray cast iron structure.

Yellow Brass

Copper	60.0—70.0	per cent
Zinc	30.0—40.0	per cent
Iron	not over 0.06	of one per cent
Other elements	not over 0.10	of one per cent

Material:

Cast or drawn.

Physical Properties:

Rods shall be straight and of homogenous structure.

Surface Finish:

The surface shall be smooth and clean.

Recommended Sizes:

5/32, ⅛, 5/32 and ¼ inch diameters.

Uses:

For brazing.

Manganese Bronze

No. 1

Copper	61.0—57.0
Zinc	37.0—41.0
Manganese	.3 to .5%
Aluminum	.05 to .15%
Other elements and impurities	1.35 to 1.65%

Uses:

For the general welding of brass sheets, plates, shapes and castings.

No. 2

Copper	61.0—57.0
Zinc	37.0—41.0
Iron	.5 to 1%
Other elements and impurities	1 to 1½%

No lead or aluminum allowed.

Uses:

For welding malleable iron, bronze and brass where high tensile strength is required.

Material:

Cast No. 1 in round sticks.

Cast No. 2 in hexagon sticks (the given dimension, being that across the hexagon.) In lengths not less than 12 inches.

Physical Properties:

Rods shall be straight and of homogeneous structure.

Surface Finish:

Rods when cast, shall be picked or rattled.

Recommended Sizes:

5/32, ¼, 5/16, ⅜ inch diameters.

Copper

Copper

To contain .03 to .06% phosphorus, or silicon .8 to 1.2% and not over .4% impurities, the rest to be copper.

Uses:

For general welding of copper sheets and rods.

Material:

Drawn, when cast, rods not to be less than 12 inches long.

Physical Properties:

Rods shall be straight and of homogeneous structure.

Surface Finish:

The surface shall be smooth and clean.

Recommended Sizes:

⅛, 5/32, ¼, 5/16, and ⅜ inch diameters.

Aluminum

No. 1

Aluminum	99.0 per cent

Uses:

For the welding of aluminum where great ductility is required.

No. 2

Aluminum	92.0 per cent
Copper	8.0 per cent

Uses:

For the general welding of aluminum.

Material:

Drawn or cast.

When cast, rods shall be not less than 12 inches long.

Physical Properties:

Rods shall be straight and of homogeneous structure.

Surface Finish:

The surface shall be smooth and clean.

Recommended Sizes:

$\frac{3}{16}$, ¼, $\frac{5}{16}$, ⅜ inch diameters.

Tests:

In the hands of an experienced welder welding rods shall demonstrate good weldability and shall flow smoothly and evenly without any unusual characteristics.

Packing:

Rods shall be delivered in coils or in straight 36 inch lengths except as otherwise specified and shall be packed and wrapped as follows:

(a) *Bundles* of 50 lb. net weight, securely wired and wrapped in heavy weatherproof paper.

(b) *Bundles* of 50 lb. net weight, securely wrapped in heavy burlap.

(c) *Boxes* or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (a).

(d) *Boxes* or kegs of 100, 200 or 300 lb. net weight, and wrapped as per paragraph (b).

(e) *Coils* of approximately 50 or 100 lb. net weight, and wrapped as per paragraph (a) or (b).

Marking:

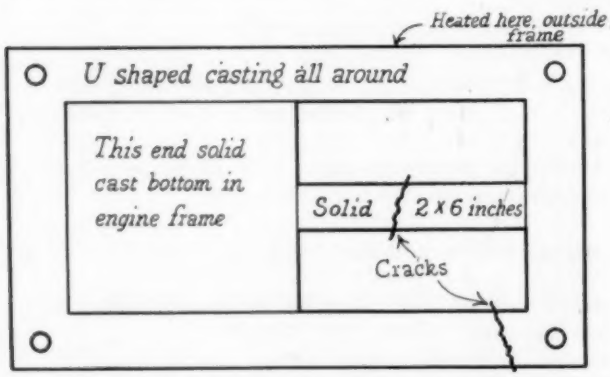
All bundles, coils, boxes or kegs shall be provided with a metal, linen or strong fibre tag securely wired to or in the case of boxes or kegs, nailed on the outside, bearing the following information:

Make .....

Nom. Weight .....

WELDING CRACKED ENGINE FRAME

It will be of interest to many welders to make note of the preheating method used by the Moline Welding Company, of Moline, Ill., in repairing the engine frame shown in the accompanying cut. The casting welded was a four-ton engine frame rectangular in shape, but in one end of which were two rectangular recesses. Between the two recesses or panels was a strip of


Heated here, outside of frame
U shaped casting all around
This end solid cast bottom in engine frame
Solid
2 x 6 inches
Cracks

Cracked Engine Frame Successfully Welded with Torch.

casting which was completely cracked. One of the panel side strips was also cracked and the welding process of repair was ordered. A serious problem confronted the welders in doing this job, for there could be absolutely no variation in the casting size when it was completed, as it had four bolt holes which were in perfect alignment for setting on foundation bolts. Any variation due to contraction or expansion would probably render the job worse off than if welding had not been performed. After abandoning a charcoal fire as a preheater, a kerosene burner was used. The casting was heated at a point on the remaining side of the panels which was not cracked, until it was red hot. Two acetylene torches with large tips were then set to work, and the welding finished in an hour. Upon completion of the job, the casting was allowed to cool and in cooling, did so without any size variation. The frame settled on the foundation bolts without difficulty.

ABOUT CHASSIS WELDING

Editor:

Will you kindly publish the following in regard to Mr. Evans' letter on Chassis Welding:

There should be no question in anyone's mind as to the feasibility of Mr. Evans' methods of chassis welding. I have personally used such methods many times during the past few months, but my experience indicates that most customers desire a weld which cannot be identified from the rest of the frame. This eliminates the methods of tacking plates to the webs or outside of the channel.

Especially in rebuilding pleasure cars or trucks where broken frames are encountered does appearance count. The customer demands a type of work which cannot be recognized as a weld. If the welded section can be recognized the job will not be accepted. Welding on the inside of the channel is a rather difficult operation, due to inaccessibility of the channel, unless the body has been removed.

In welding auto frames the operator must always consider the conditions under which an automobile is used. Were it not for excessive vibration the plate used for reinforcing could in all probability be eliminated. The continued fatigue strain and frequent abnormal shocks require that the welded section be stiffened, and for this reason plates have been used. Building up a wide column of metal serves the identical purpose. On pleasure cars this method has proven itself a success, while its use on heavy trucks has given the kind of satisfaction that job welding shops like to know about. "They never come back" except for other welding repairs.

Yours for welding,

B. Heyman.

CAUSES FOR POOR WELDS ON SAFE ENDS

Investigating complaints of trouble experienced in the welding of safe ends, we find that this can be attributed mostly to one or two things, or both—improper construction of the furnace and the roller welding machine not being speeded up to the revolutions necessary to make a quick and sound weld. The roller welding machine should have a speed of not less than 450 revolutions at the fly wheel. The material being of a light wall, it cools very rapidly, and therefore must have quick action for fusing. In our opinion, some of the trouble complained of is due to the oil burners being set so that they play directly upon the material to be heated; especially is this a fact in short furnaces. Where the oil is of a good grade and light, there seems to be no trouble in properly heating the material, but when the oil is dirty and of a heavy grade, proper combustion will not take place in the short distance. The results are that where specks of this oil strike the metal along the line of the weld the material will not amalgamate; the result is a defective weld. The burner should be placed so that it will not blow directly upon the material; better at right angles, either top or bottom. In some cases they mixed heavy crude with kerosene oil; this brought about better combustion and better results were obtained from the furnace. The heavy oil clogging the burner causes the temperature to fluctuate, and the material is wasted in the furnace without being given the proper degree of heat for welding. The temperature of the furnace should be kept above the welding heat; if possible, 300 deg. to 400 deg. F. and it is the opinion of the committee that it is necessary to use a pyrometer only in cases where the desire is to establish the proper heat for welding. This, however, is not necessary with an experienced flue welder, as his eye will readily detect the proper degree of heat for welding, and the pyrometer should only be used as a matter of education. —*From the report on Welding Safe Ends, of the Master Boiler Makers' Association.*

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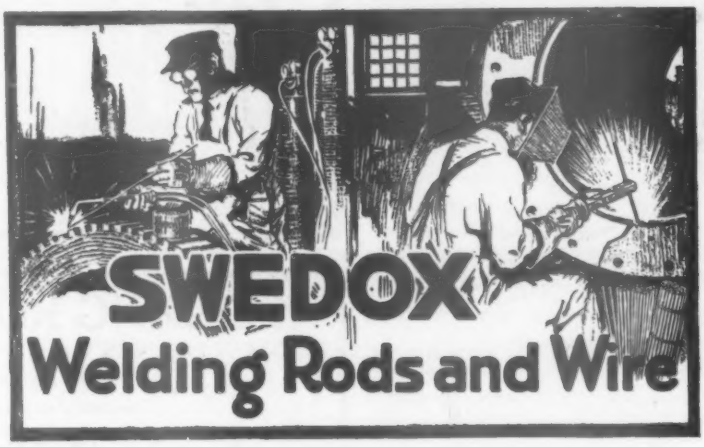

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Position Wanted—Electric arc and oxy-acetylene welder with long experience in railroad and general repair work (have record of building up one welding shop from nothing to a profitable business); can take care of welding department or train welders in either process; would consider buying part interest in going shop; capable of carrying on experimental work in laboratory. Address 15, care The Welding Engineer.

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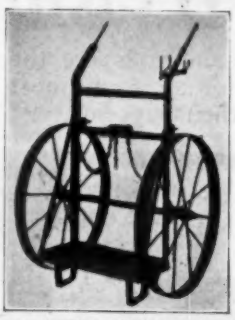

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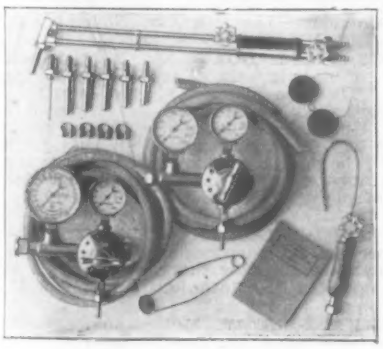

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PIPE WELDING ON A LARGE SCALE—How a large Canadian manufacturer handles a big problem in pipe construction.—Canadian Welding Journal, October.

INFLUENCE OF IMPURITIES IN MILD STEEL ON AUTOGENOUS WELDING—A large carbon content is harmful. The silicon content should be as small as possible. A large enough manganese content seems to compensate for the bad effects of silicon and sulphur. Sulphur is the most harmful element. Traces of chronium and nickel have not shown any disadvantages. This discussion is an abstract of test results published in Switzerland—Revue de la Soudure Autogene, October.

REPAIRING LOCOMOTIVE BOILERS BY ELECTRIC WELDING—Special committee of Master Boiler Makers' Association reports best methods of reconditioning boilers. Discusses welding of complete fireboxes, preparing half side and door sheets for welding, firebox sheet knuckle patching, repairing small portions of side sheets, welding of seams, broken mud rings, and improper welding of firebox plates.—The Boiler Maker, November.

STANDARDS OF RAILROAD SHOP WELDING PRACTICE, by G. M. Calmbach—Workable general rules for railroad welding are given, also typical examples of proved boiler welding practice. Fitting, preparing and welding of fireboxes. The essential and important things to consider in making a weld are: condition of surfaces, bevel of sheets, position of sheets, provision for expansion and contraction, proper filler metal.—Railway Maintenance Engineer, December.

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WELDING, PARTICULARLY HAMMER WELDING, by E. E. Thum—Brief discussion of various modern methods of welding indicating advantages and limitations of each, and the field for hammer weldng heavy pressure vessels. Operations necessary for hammer welding steel sheets. Objections to autogenous welding based on necessity for skill and care, and difficulty of inspection.—Chemical and Metallurgical Engineering, September 21.

TUBE BENDING AND WELDING, by J. F. Springer—Methods of making bends without crushing the tubing, and making butt welds in small pipes.—Automobile Dealer and Repairer, November.

SAFETY ASPECTS OF OXY-ACETYLENE, by R. C. Rohrabacher—The oxy-acetylene industry is today much freer from hazards than many others whose elements of danger åre so familiar to us that they are sources of scarcely any public alarm at all. In most "acetylene" accidents reported, it is found upon investigation that acetylene had no connection whatsoever with the accidents.—Acetylene Journal, December.

FUSION WELDING AND THE PROCESSES IN USE, by S. W. Miller—Composition of welding metal used. Causes of failures are lack of fusion and oxidation. Effect of nitrogen. Welder must be skilled, and care taken to test welds.—The Iron Age, November 24.

ELECTRICALLY WELDED STEEL BOATS, by A. Lagane—The author advocates the use of electric welding instead of riveting for the steel hulls of boats. He uses metallic electrodes with a non-metallic coating, or the so-called "quasi-arc." As examples of accomplished jobs a 20-m. x 4-m. x 2½- boat and a 500-ton cargo boat are given. The former had to be transported on land for a distance of 3 miles (4.8 km.) before it was launched, subjecting all welds to a very abnormal stress, but no damage to the welded joints resulted.—Revenue Générale de l' Electricit , Sept. 24, 1921.

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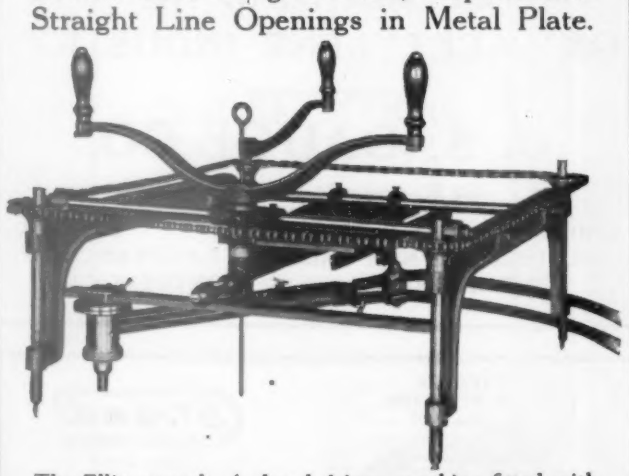

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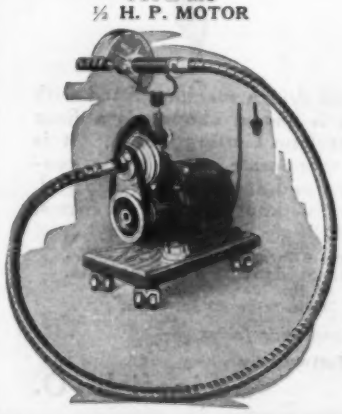

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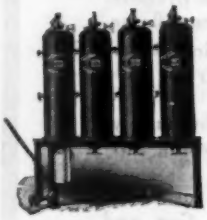

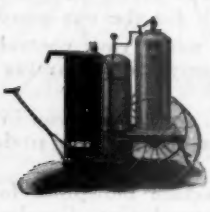

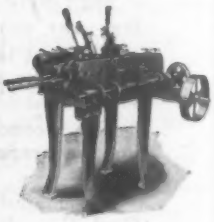

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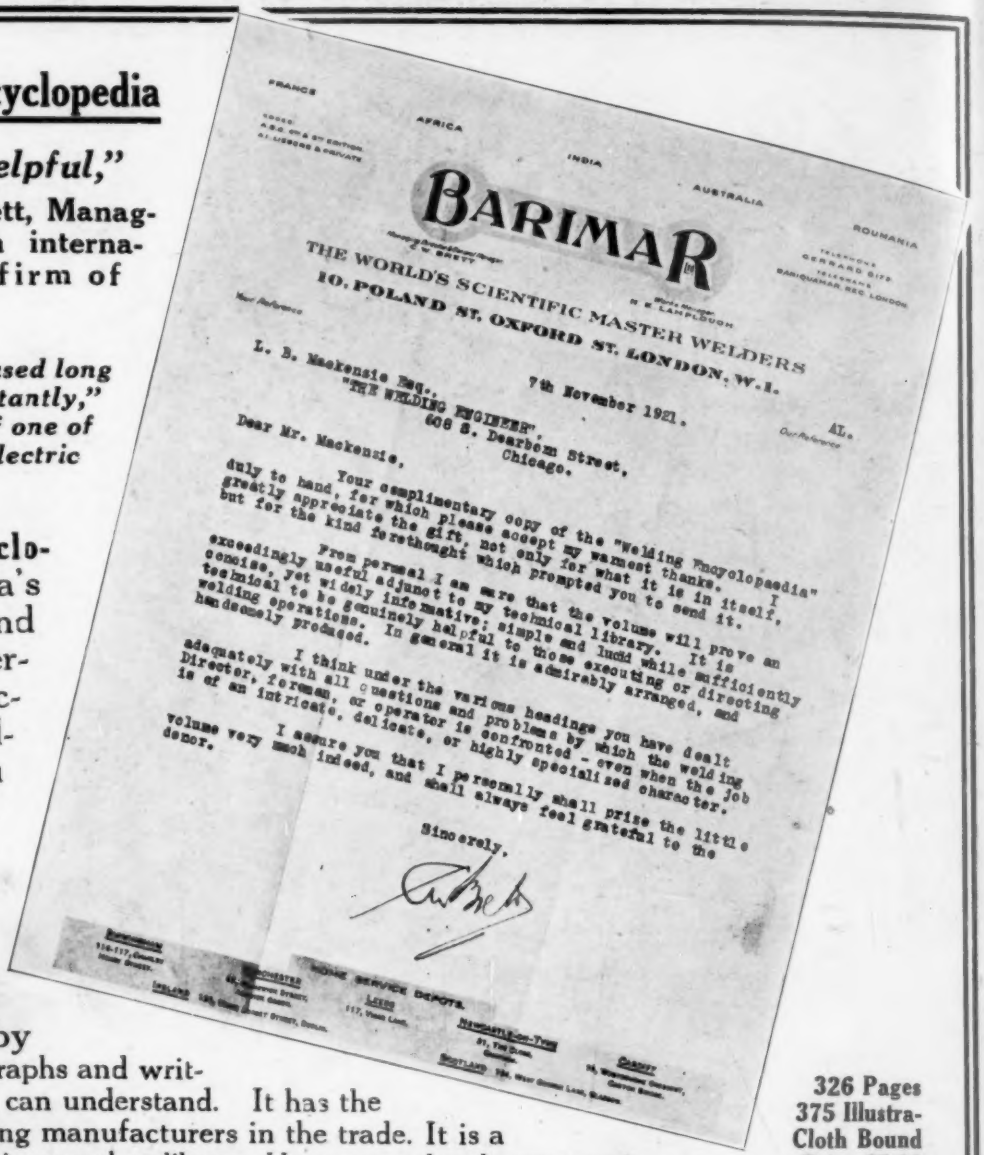

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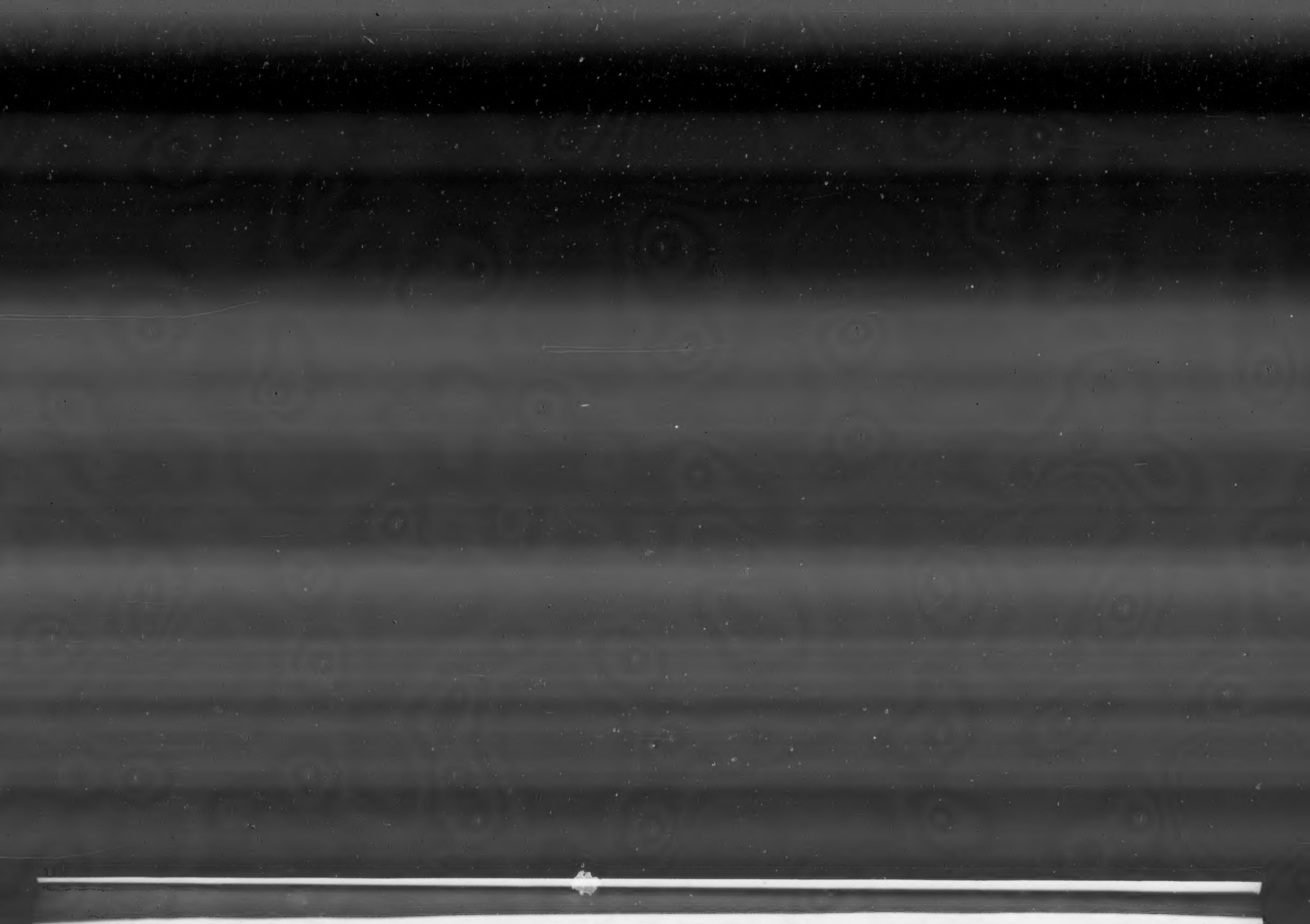
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